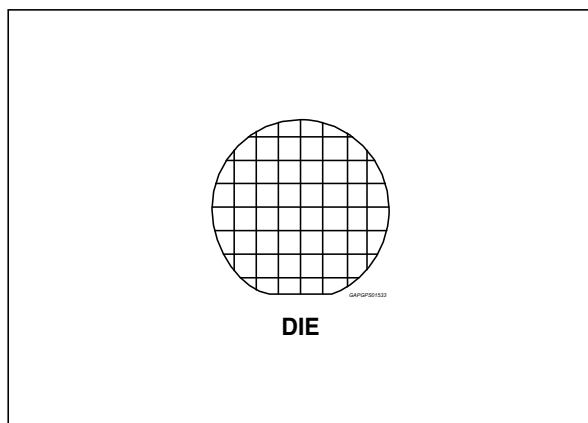


Automotive multifunction smart alternator regulator

Datasheet - production data



Features

- AEC-Q100 qualified
- Fully monolithic design



- Low side field driver
- Thermal protection
- Field short circuit protection
- Protected diagnostic lamp driver
- Protected high side relay driver
- Complex diagnostics
- Load response control
- DFM output (field monitor)

Description

The L9408F is a monolithic multifunction alternator voltage regulator.

It includes the control section, the field power stage, fault diagnostic circuit which drives a warning lamp.

Table 1. Device summary

Order code	Package	Packing
L9408FDIETR	DIE	-

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1 Pad description

All dimensions are in micrometers.

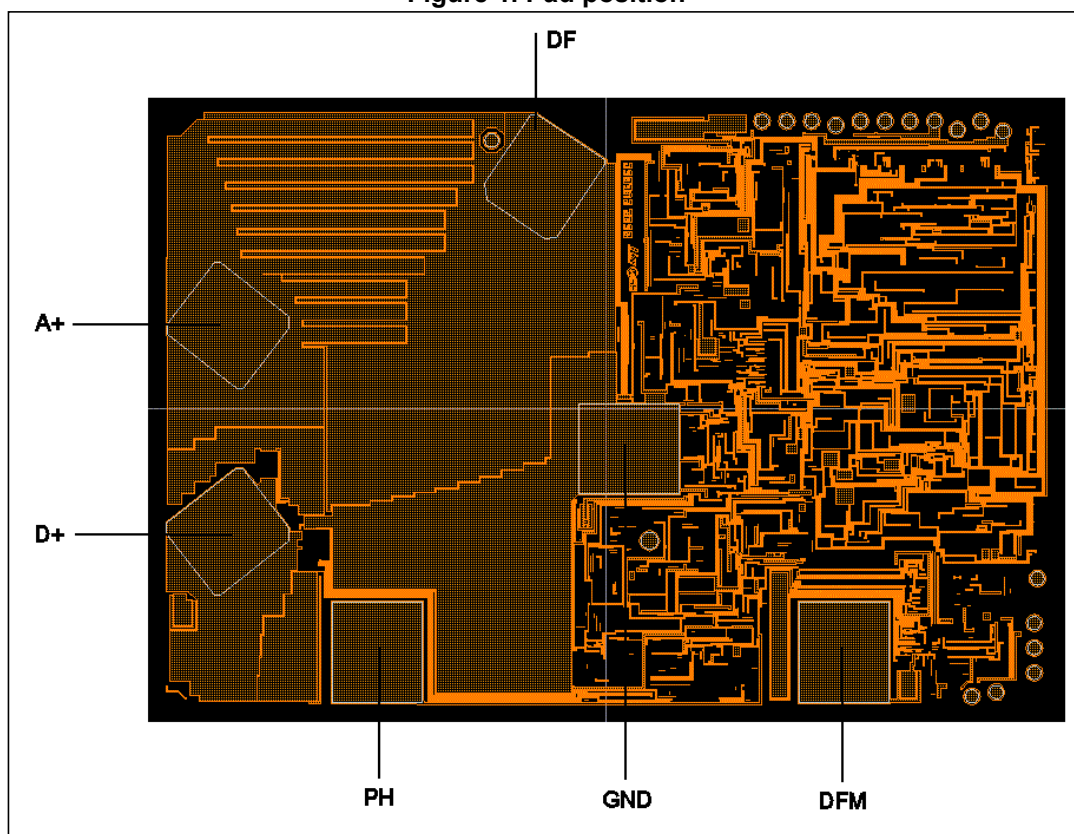
Pad placement values correspond to each pad center coordinates.

Pad placement origin is the lower left corner of the die.

Table 2. Pad description

Pad name	Pad placements		Pad dimensions	
	X	Y	X	Y
test	4299.25	4233.25	102.5	102.5
DF	4021.625	3827.25	948.25	917.5
PVREG	4445.25	2171.75	102.5	102.5
P51	4445.25	1982.75	102.5	102.5
P52	4445.25	1793.75	102.5	102.5
P4	4414.25	1608.75	102.5	102.5
P3	4445.25	1423.25	102.5	102.5
P1	4445.25	1234.25	102.5	102.5
P2	4445.25	1044.75	102.5	102.5
P0	4445.25	856.25	102.5	102.5
P54	4380.75	680.25	102.5	102.5
P53	4445.25	504.25	102.5	102.5
P50	4364.75	334.75	102.5	102.5
OSCITEST	961.25	71.75	102.5	102.5
P13	622.75	95.25	102.5	102.5
P12	432.25	94.75	102.5	102.5
P11	243.25	94.75	102.5	102.5
P10	94.75	385.75	102.5	102.5
P9	64.75	571.25	102.5	102.5
DFM	398.5	1546.5	762.0	685.0
TW	1248.25	3029.75	128.5	128.5
GND	1950.0	3187.0	685.0	762.0
PH	398.5	5105.5	762.0	685.0
D+	1319.25	6244.5	933.0	963.5
A+	2888.25	6243.0	933.0	963.5

Figure 1. Pad position



2 Electrical specifications

2.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_S	DC supply voltage (2 min. @ 25 °C)	24	V
-	Transient supply voltage (load dump); $t < 500$ ms @ 25 °C	40	V
-	Transient supply voltage (low energy spikes pulse ISO7637/1)	60	V
P_{tot}	Total power dissipation (@ $T_{case} = 150$ °C, $I_{field} = 5$ A)	5	W
-	Reverse voltage all pins @ 25 °C, $T = 15$ s	-2.5	V
-	DC pin current on DF, A+, GND pins (bonding limitation)	11	A
-	ESD voltage (Human body model)	±4	kV
T_j	Junction temperature	-40 to 150	°C
T_{stg}	Storage temperature	-40 to 170	°C

2.2 Electrical characteristics

$T_j = -40$ to 150 °C; unless otherwise specified.

Table 4. Electrical characteristics

Symbol	Parameter	Test condition	Min.	Typ.	Max	Unit
V_{bat}	Operating supply voltage	-	8.5	-	18	V
I_{b-sink}	Supply battery current	-	-	-	50	mA
I_{b-stby}	Standby current	$V_{bat} = 12$ V, $T = 25$ °C	-	-	300	μ A
		$V_{bat} = 12$ V, $T = 40$ °C	-	-	500	
V_{reg}	Regulated voltage & therm. drift (standard version)	$I_{alt} = 0.5 \cdot I_{nom}$; $rpm = 0.5 \cdot RPM_{MAX}$; $T = 20$ °C	14.3 -4	14.45 -3	14.6 -2	V mV/°C
$V_{reg}^{(1)}$	Regulated voltage & therm. drift (optional version)	$I_{alt} = 0.2 \cdot I_{nom}$; $rpm = 0.5 \cdot RPM_{MAX}$; $T = 20$ °C	14.1 -11.5	14.5 -10	14.9 -8.5	V mV/°C
f_{sw}	Switching frequency	in FSDF	30	-	400	Hz
V_{rpm}	Delta V_{rpm}	$1800 < rpm < 12000$; $I_{alt} = 0.3 \cdot I_{nom}$	-	-	200	mV
V_{load}	Delta V_{load}	$0.1 \cdot I_{nom} < I_{alt} < 0.9 \cdot I_{nom}$; $rpm = 0.5 \cdot RPM_{MAX}$	-	-	200	mV
V_{reg}	Regulated voltage without battery	$I_{alt} = 3$ A resistive	-	-	16	V

Table 4. Electrical characteristics (continued)

Symbol	Parameter	Test condition	Min.	Typ.	Max	Unit
V_{OV}	D+ drivers disable threshold	Voltage on pin A+ to have D+ = OFF	18	-	22	V
T_{j-sd}	Thermal shut-down	DF = Off state D+ = Off state	170	-	200	°C
$T_{j-sd-hys}$	Thermal shut-down hysteresis	DF, D+ = from off state (due to thermal shutdown) to on	2	-	10	°C
R_{on}	Low side driver R_{dson}	$T_j = 150\text{ °C}$; $I = 3\text{ A}$	-	-	230	mΩ
		$T_j = 25\text{ °C}$; $I = 1\text{ A}$	-	-	130	mΩ
V_F	Freewheeling diode DF	$I_F = 5\text{ A}$	-	-	2	V
$I_{SC}^{(2)}$	Short circuit threshold DF	DF = 12 V; $T = -40\text{ to }25\text{ °C}$	8.5	-	18	A
		DF = 12 V; $T = 25\text{ to }125\text{ °C}$	7	-	18	
V_{s1}	Output short to ground threshold DF	-	2.1	-	3.9	V
FS_{DF}	Pre-excitation F.S.D.F	$f = 348\text{ Hz} \pm 15\%$	10.62	12.5	14.38	%
t_{ST}	Soft start delay time	Activated at first running-on only	-	0		s
t_{SL}	Soft attack time	From 0 to 100% field duty cycle	2.5	2.88	3.39	s
BI	Soft attack blind zone	% of maximum D.C. immediate variation of soft attack	0	-	10	%
t_{rise}	Output voltage rise time	$I_{field} = 3\text{ A}$ resistive	5	-	50	μs
t_{fall}	Output voltage fall time		5	-	50	
I_{flk}	Output field driver leakage current	DF = 24 V	-	-	1	mA
V_{HS}	High side driver saturation voltage	$I_{source} = 1\text{ A}$	-	-	1.2	V
V_{LS}	Low side driver saturation voltage	$I_{sink} = 0.25\text{ A}$	-	-	1.5	V
V_{LSB}	Self bias without supply lamp driver voltage	-	-	-	4	V
I_{HSC}	High side current limitation	A+ = 17.5 V; D+ = GND	1.2	-	3	A
I_{LSC}	Low side current limitation	A+ = D+ = 17.5 V	0.45	-	1.5	A
V_{thD+}	Enable regulator voltage D+	-	0.8	1	1.15	V
I_{thD+}	Enable regulator pull-down current	-	0.4	-	3.5	mA
DISAB	Soft attack inhibition frequency	-	265	313	360	Hz
EN ₁	Soft start delay time enable frequency	-	88	104	120	Hz
EN _{1_hy}	Soft start delay time enable frequency hysteresis	-	EN ₁₋₈	EN ₁₋₁₀	EN ₁₋₁₂	Hz

Table 4. Electrical characteristics (continued)

Symbol	Parameter	Test condition	Min.	Typ.	Max	Unit
V_{PHL1}	Enable control voltage PH high threshold	Square wave 1 kHz	0.67	0.795	0.92	V
V_{PHL2}	Enable control voltage PH low threshold	-	$V_{PHL1} - 0.48$	$V_{PHL1} - 0.57$	$V_{PHL1} - 0.66$	V
t_{PH}	PH filtering time	-	15	-	120	μs
V_{PHH1}	Diag. phase loss high voltage	-	9	10.25	11.5	V
V_{PHH2}	Diag. phase loss low voltage	-	4	5	6	V
t_{PHD}	Diagnostic PH filtering time	-	50	-	200	μs
I_{PH}	Phase pull-down current	-	1	-	8	mA
t_D	Diagnostic alarm delay	-	0.48	0.575	0.65	s
f_{DFM}	DFM open drain switching frequency	in FSDF	30	-	400	Hz
V_{OL}	Output low voltage DFM	$I_{sink} = 25$ mA	-	-	1.5	V
I_{dfml}	Short circuit protection DFM	$V_{DF_MON} = 12$ V	25	-	200	mA
I_{lk}	Output leakage current DFM	$V_{DF_MON} = 24$ V	-	-	0.1	mA
t_{TM}	DFM output voltage rise time	$R = 2.7$ k Ω ; $C = 1$ nF; $V_{alim} = 13.5$ V	0.05	-	50	μs
T_{TD}	DFM output voltage fall time	$R = 2.7$ k Ω ; $C = 1$ nF; $V_{alim} = 13.5$ V	0.05	-	50	μs

1. Available through a metal option of the actual device.
2. Not tested on the die version.

Figure 2. Application diagram

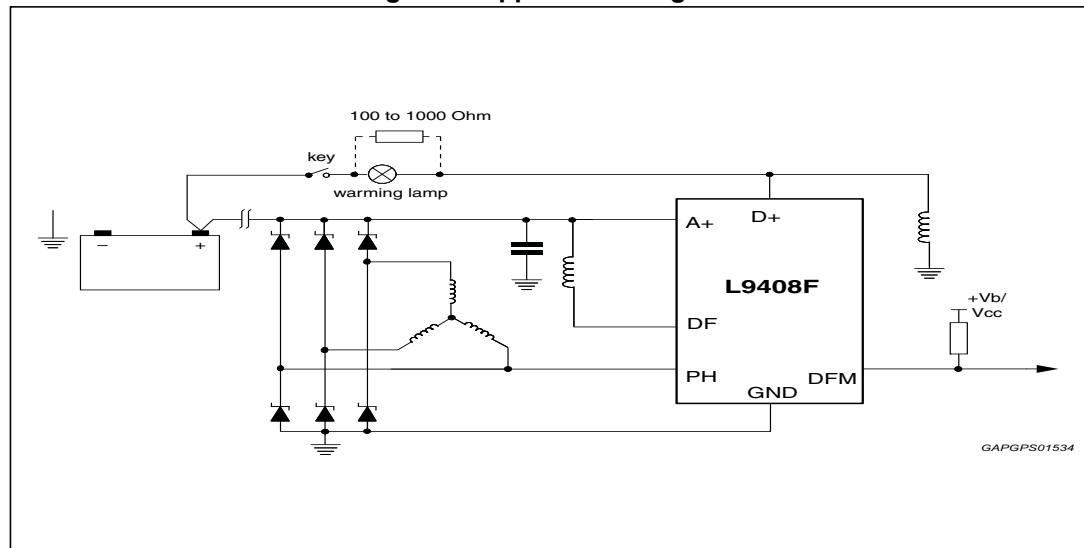


Table 5. Thermal compensation (V_{reg} , standard version)

Temperature [°C]	Vreg		
	Min. [V]	Typ. [V]	Max. [V]
-40	14.43	14.645	14.86
25	14.30	14.45	14.60
125	13.90	14.15	14.40

Figure 3. Thermal compensation diagram (Vreg, standard version)

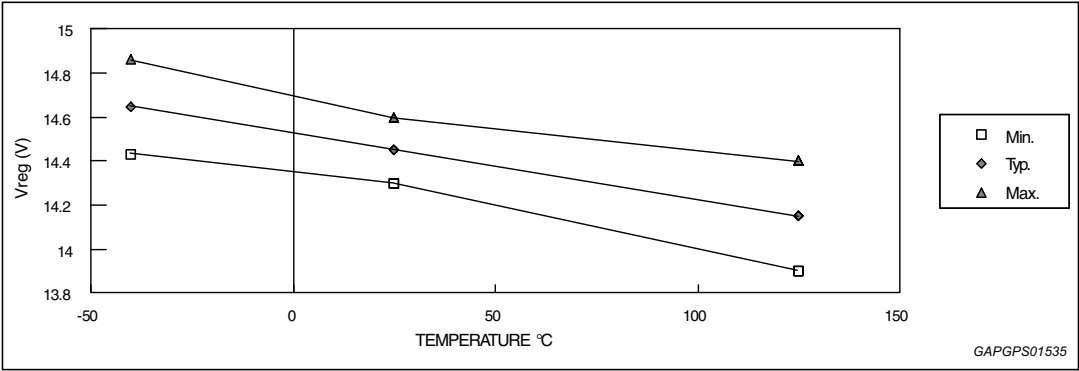


Figure 4. Load transient example

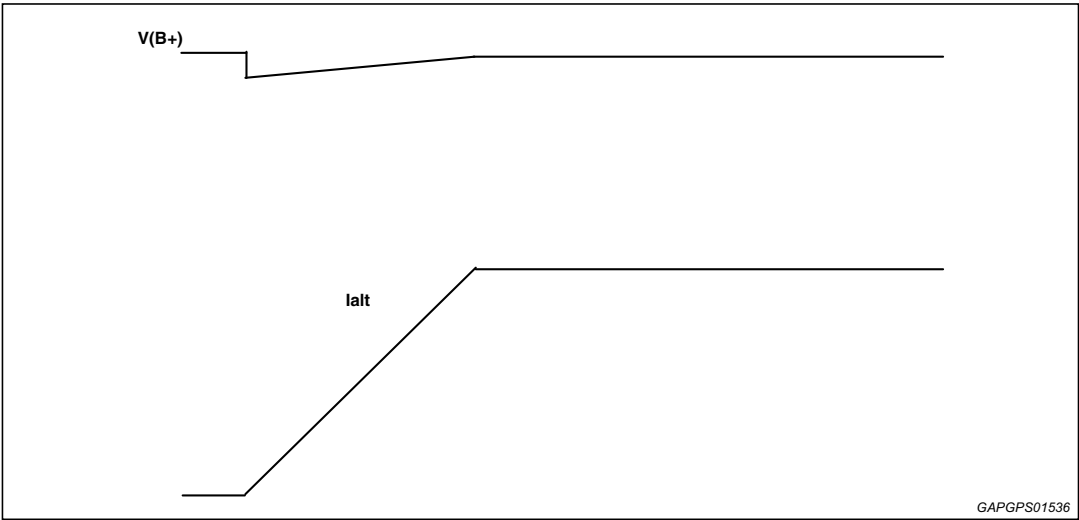


Figure 5. Start-up timing

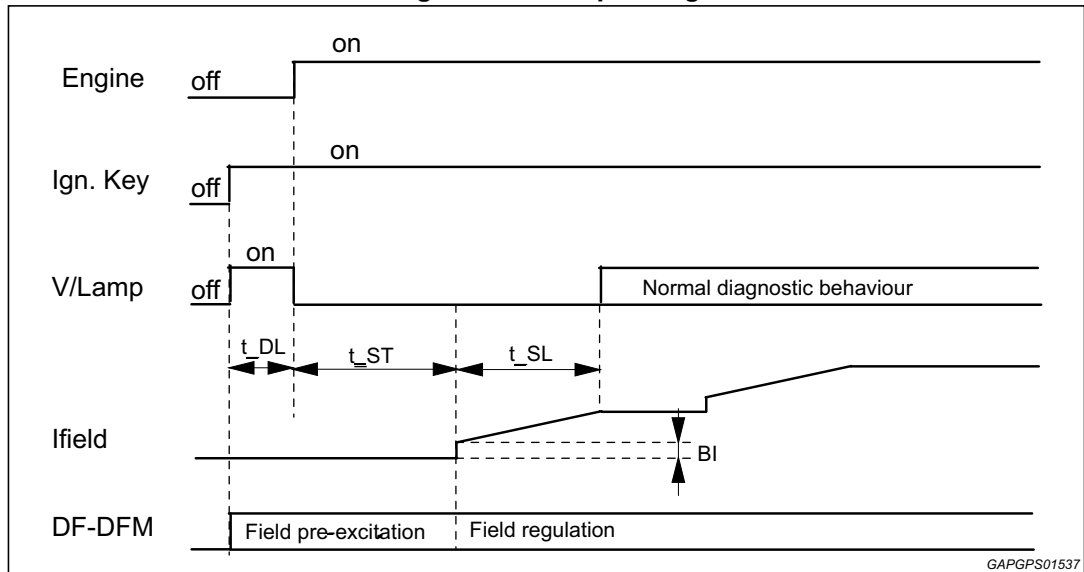


Table 6. Fault detection

Root cause	Signal	Effect	Test detect
Alternator belt breaking	PH	Alternator dis-excitation	$V_{PH} < V_{PHH} \ \& \ V_{A+} < V_{reg}$
Brushes open	PH	Alternator dis-excitation	$V_{PH} < V_{PHH} \ \& \ V_{A+} < V_{reg}$
Field interruption	PH	Alternator dis-excitation	$V_{PH} < V_{PHH} \ \& \ V_{A+} < V_{reg}$
Field short circuit to the battery	PH	Alternator dis-excitation	$V_{PH} < V_{PHH} \ \& \ V_{A+} < V_{reg}$
Field short circuit to the ground	DF	Overvoltage	$DF < VS1 \ \& \ V_{A+} > V_{reg}$

The diagnostic result is disabled during the Soft-start delay time t_{ST} and the soft attack timing t_{SL} .

Figure 6. Load response control

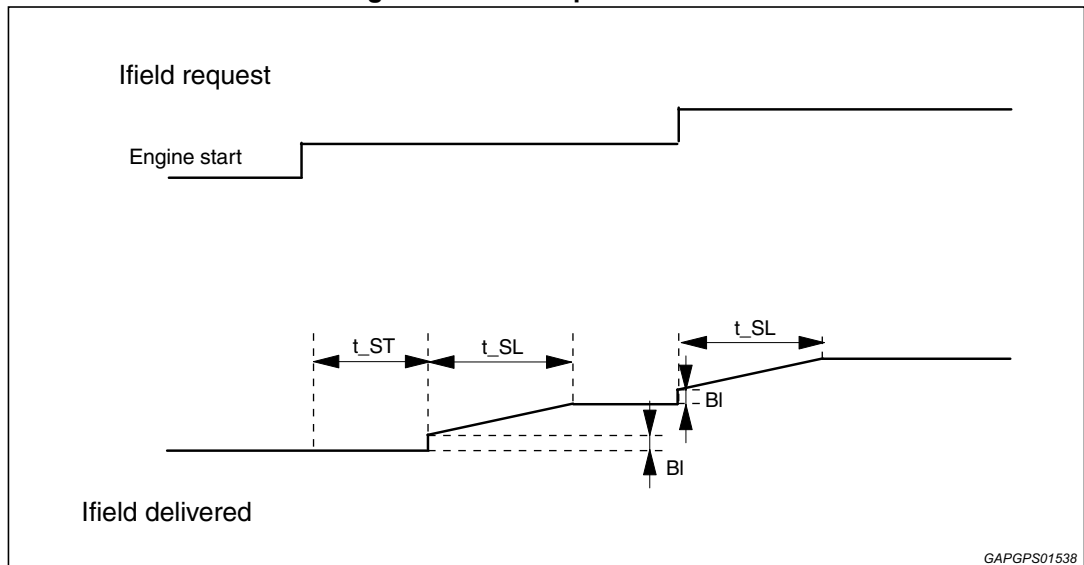
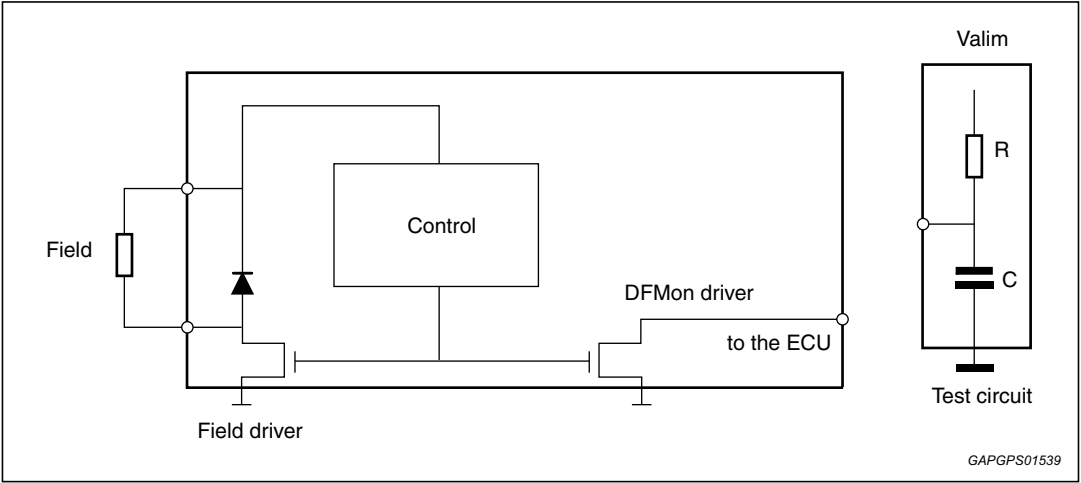


Table 7. Application summary features (standard option)

Regulation	Thermal drift	Pre-exc.	Soft start	Soft attack	DF monitor
Voltage (V)	(mV/°C)	FS_DF (%)	Delay Timing (s)	Timing (s)	function
14.45	-3	12.5	0	2.88	YES

Figure 7. DFMonitor electrical configuration



3 Revision history

Table 8. Document revision history

Date	Revision	Changes
16-Jun-2016	1	Initial release.

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