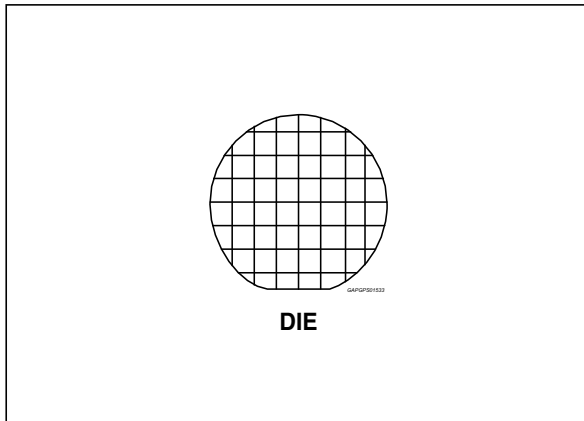


Automotive multifunction smart alternator regulator

Datasheet - production data



- 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.

Features

- AEC-Q100 qualified
- Fully monolithic design



Table 1. Device summary

Order code	Package	Packing
L9408FDIETR	DIE	-

Contents

1	Pad description	5
2	Electrical specifications	7
	2.1 Absolute maximum ratings	7
	2.2 Electrical characteristics	7
3	Revision history	13

List of tables

Table 1.	Device summary	1
Table 2.	Pad description	5
Table 3.	Absolute maximum ratings	7
Table 4.	Electrical characteristics	7
Table 5.	Thermal compensation (V_{reg} , standard version).	10
Table 6.	Fault detection	11
Table 7.	Application summary features (standard option)	12
Table 8.	Document revision history.	13

List of figures

Figure 1.	Pad position	6
Figure 2.	Application diagram	9
Figure 3.	Thermal compensation diagram (Vreg, standard version)	10
Figure 4.	Load transient example.	10
Figure 5.	Start-up timing.	11
Figure 6.	Load response control	11
Figure 7.	DFMonitor electrical configuration	12

1 Pad description

All dimensions are in micrometers.

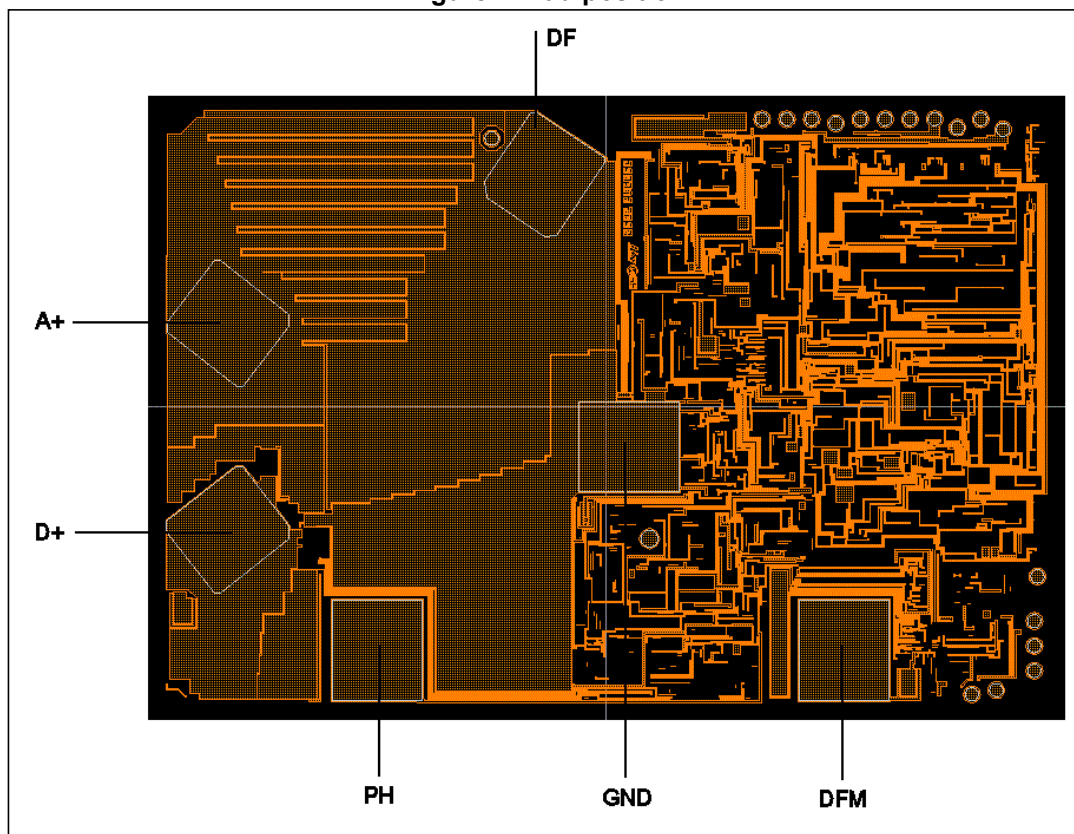
Pad placement values correspond to each pad center coordinates.

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	µA
		$V_{bat} = 12$ V, $T = 40$ °C	-	-	500	
V_{reg}	Regulated voltage & therm. drift (standard version)	$I_{alt} = 0.5 \cdot I_{nom}$;	14.3	14.45	14.6	V mV/°C
		$rpm = 0.5 \cdot RPM_{MAX}$; $T = 20$ °C	-4	-3	-2	
$V_{reg}^{(1)}$	Regulated voltage & therm. drift (optional version)	$I_{alt} = 0.2 \cdot I_{nom}$;	14.1	14.5	14.9	V mV/°C
		$rpm = 0.5 \cdot RPM_{MAX}$; $T = 20$ °C	-11.5	-10	-8.5	
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 °C; I = 3 A	-	-	230	mΩ
		T _j = 25 °C; I = 1 A	-	-	130	mΩ
V _F	Freewheeling diode DF	I _F = 5 A	-	-	2	V
I _{fSC} ⁽²⁾	Short circuit threshold DF	DF = 12 V; T = -40 to 25 °C	8.5	-	18	A
		DF = 12 V; T = 25 to 125 °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 Hz ±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
Bl	Soft attack blind zone	% of maximum D.C. immediate variation of soft attack	0	-	10	%
t _{rise}	Output voltage rise time	I _{field} = 3 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 A	-	-	1.2	V
V _{LS}	Low side driver saturation voltage	I _{sink} = 0.25 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	$I_{sink} = 25 \text{ mA}$	-	-	1.5	V
I_{dfml}	Short circuit protection DFM	$V_{DF_MON} = 12 \text{ V}$	25	-	200	mA
I_{lk}	Output leakage current DFM	$V_{DF_MON} = 24 \text{ V}$	-	-	0.1	mA
t_{TM}	DFM output voltage rise time	$R = 2.7 \text{ k}\Omega$; $C = 1 \text{ nF}$; $V_{alim} = 13.5 \text{ V}$	0.05	-	50	μs
T_{TD}	DFM output voltage fall time	$R = 2.7 \text{ k}\Omega$; $C = 1 \text{ nF}$; $V_{alim} = 13.5 \text{ V}$	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

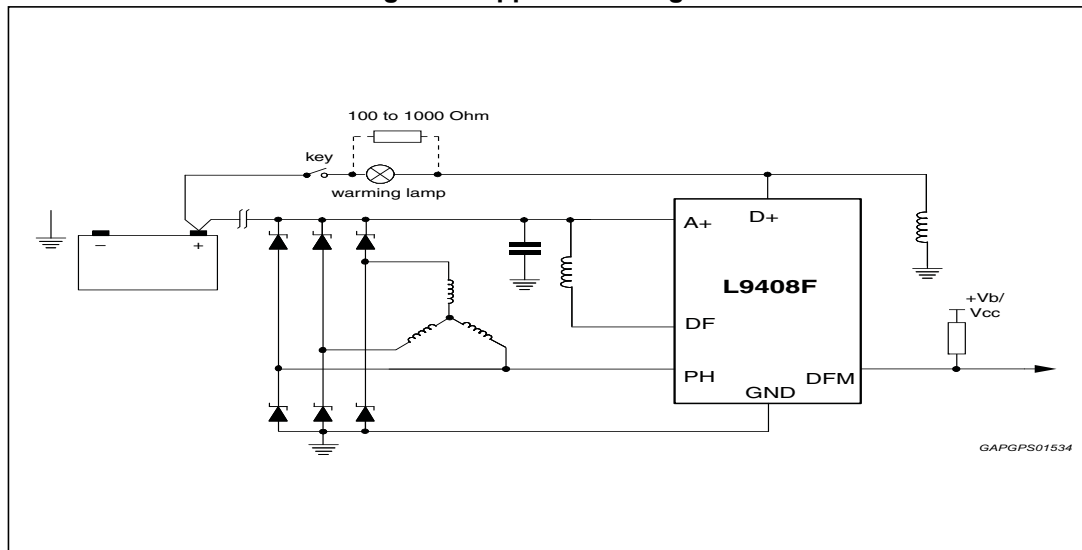


Table 5. Thermal compensation (V_{reg} , standard version)

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)

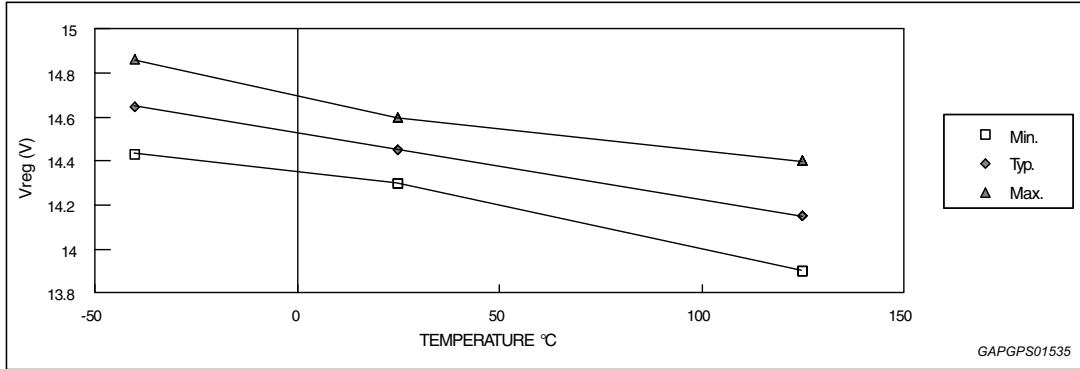


Figure 4. Load transient example

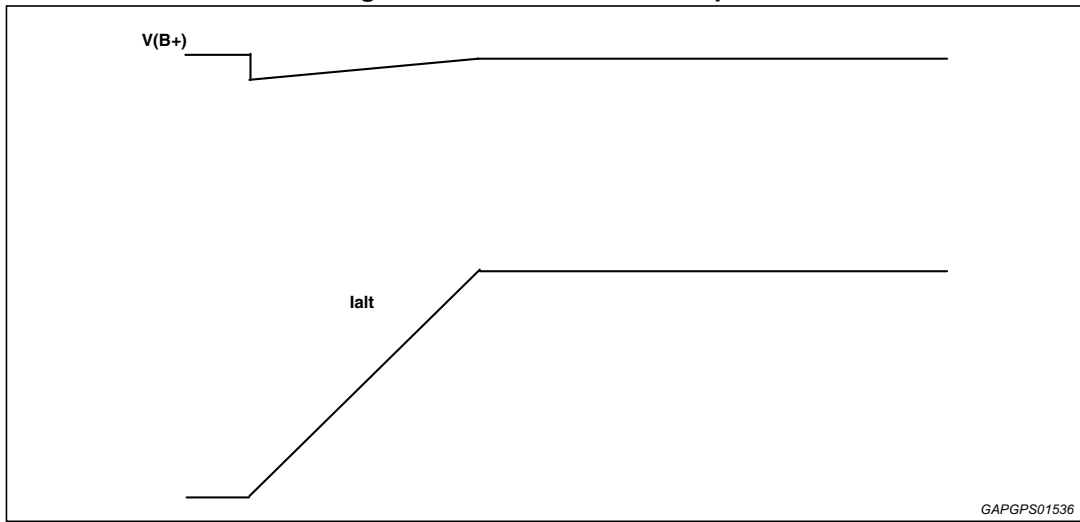


Figure 5. Start-up timing

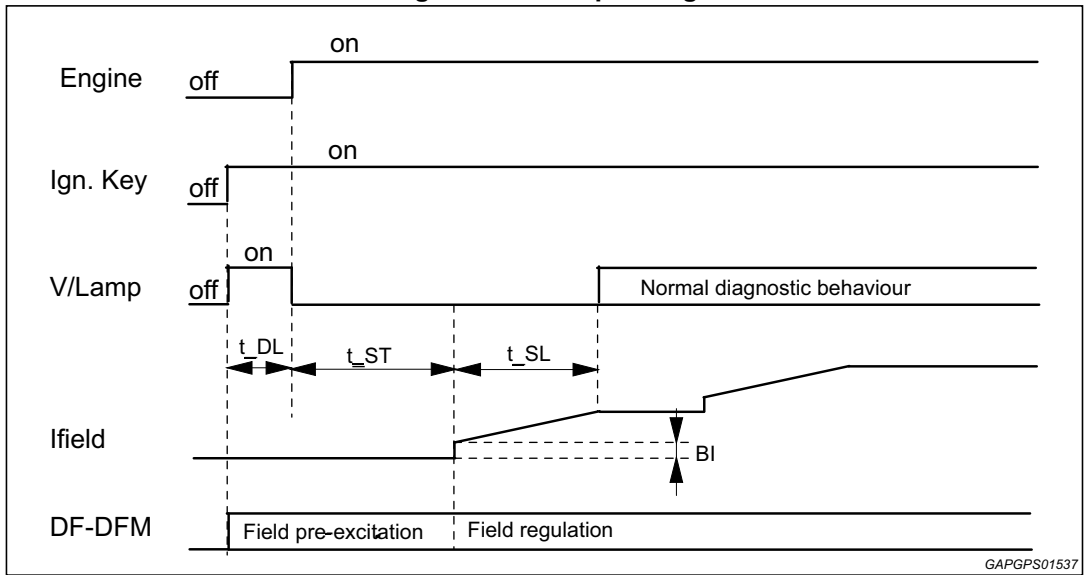


Table 6. Fault detection

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

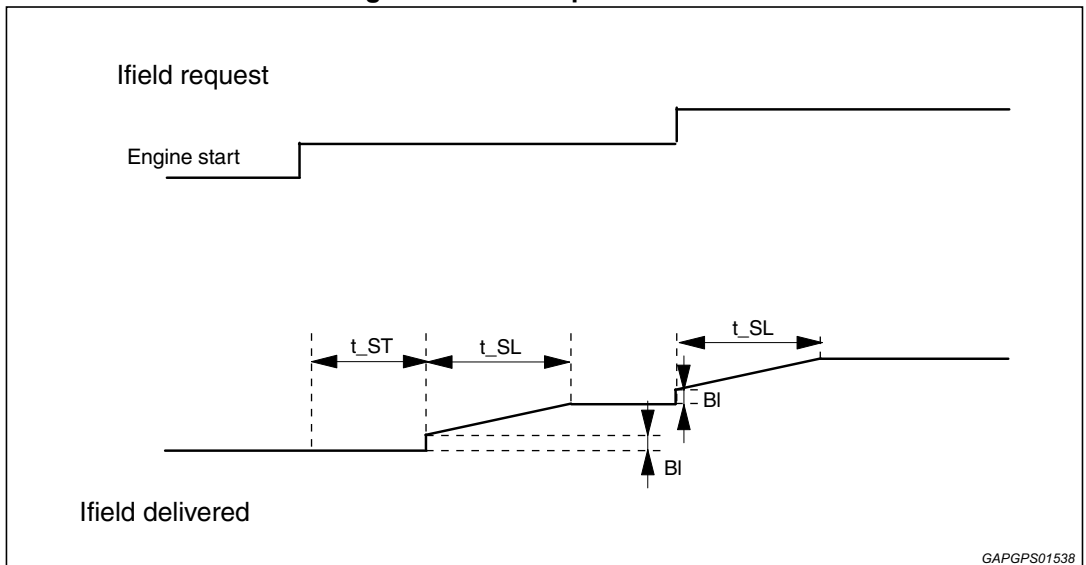
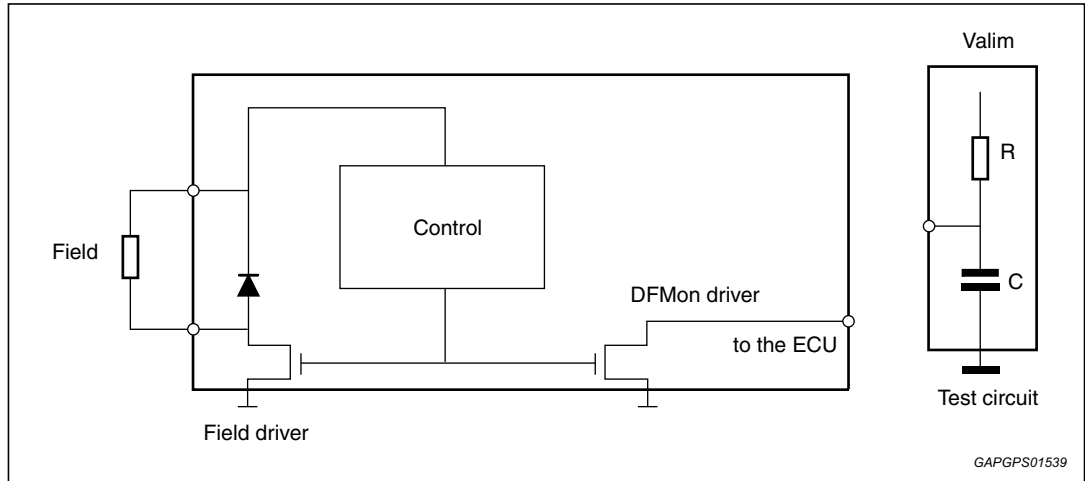


Table 7. Application summary features (standard option)

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.

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2016 STMicroelectronics – All rights reserved