Automotive Electronics

Technical Customer Documentation

CR719 – 14V Multifunctional Alternator Regulator

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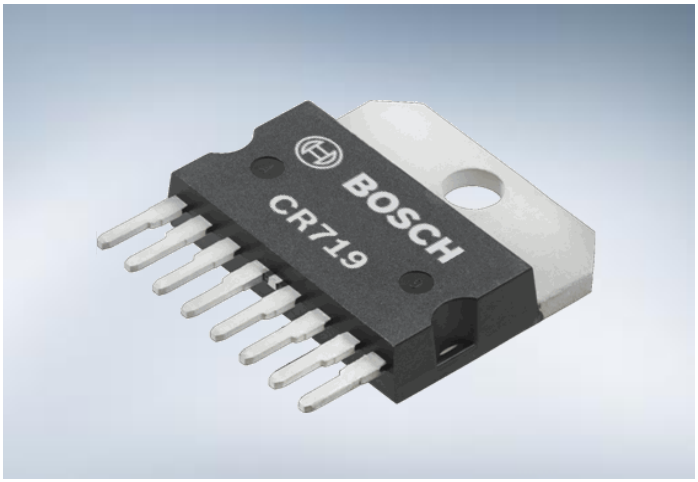

Customer benefits

- Fully integrated single chip alternator control IC
- Designed for closed loop voltage control for 14V automotive synchronous alternators
- Autonomous multifunctional operation
- Available as bare die and in MW8 package

Features

- Fixed frequency regulation with pulse width modulation
- Temperature compensated regulating voltage
- High side output stage with defined slew rate and freewheeling diode
- Standby mode
- Wake up via L terminal
- Self-start from V terminal in case of missing lamp connection
- Integrated lamp and relay driver
- Duty cycle range from 0% to 100%
- Duty cycle monitor output signal
- Load response functionality
- Different regulation modes for smooth start up
- Error indication vial L terminal

Functions to protect alternator and battery

- High temperature protection
- Overcurrent and short circuit protection
- Overvoltage limitation

Pin		Function
1	DFM	Field monitor output
2	L	Lamp
3	n.c.	Not connected
4	B+	Battery
5	n.c.	Not connected
6	V	Phase signal input
7	DF	Field high side driver
8	GND	Ground

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1. Functional description

The CR719 Regulator IC is a 14V automotive multifunctional regulator, controlled by a lamp terminal to work in a brush holder housing attached to a multi-phase synchronous alternator with 6 or 8 pole pairs (see chapter 2 Available variants).

The product's safety and robustness requires operation within the boundary conditions described in this document. These boundaries have been defined to our best engineering and application experience. Please check applications that may exceed the limits or require additional parametric information with your sales representative. This document describes both the MW8 packaged and bare die IC products.

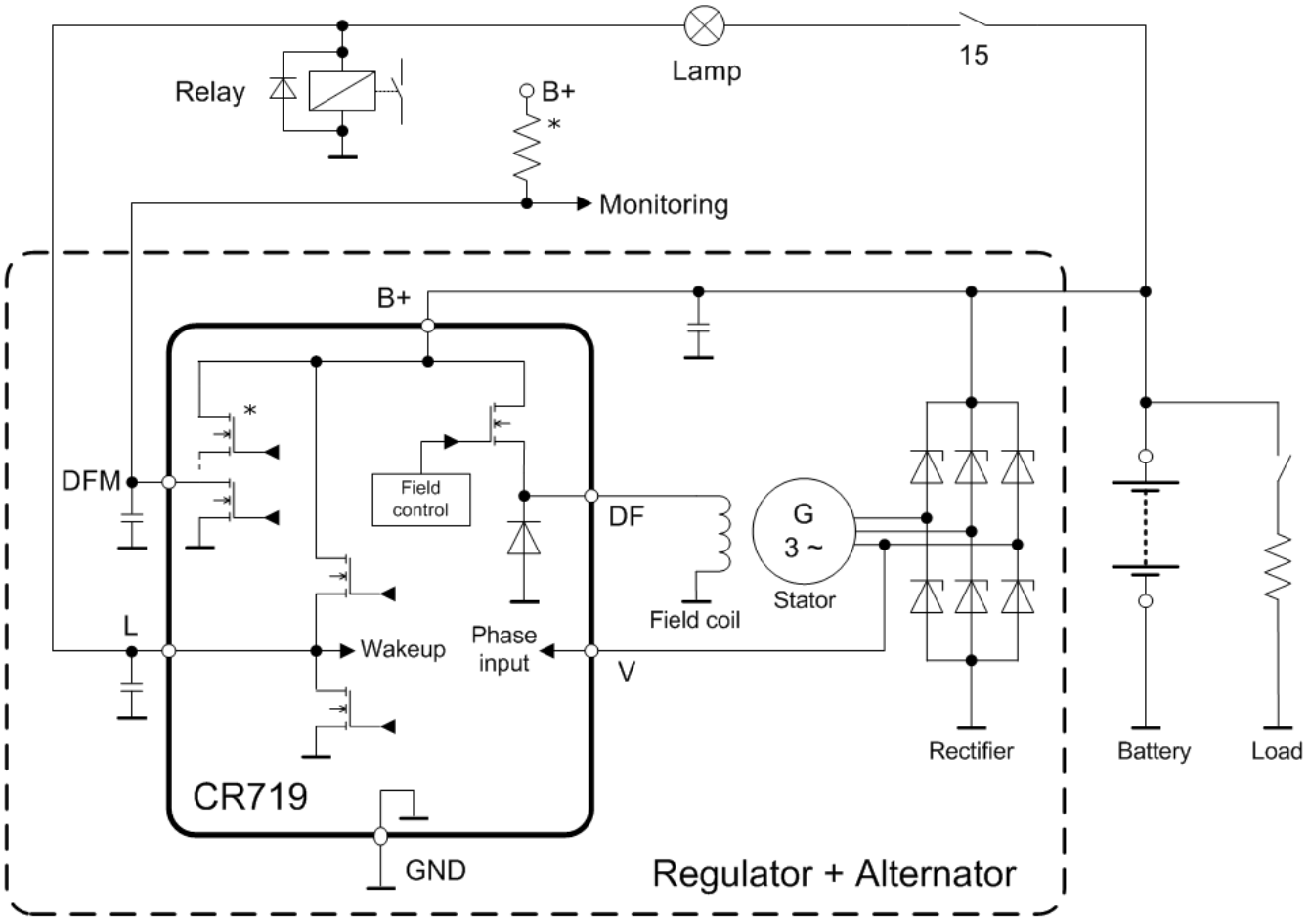


Figure 1 Application diagram

* The DFM driver in variant CR719K is a push-pull configuration. In this case, the pull-up resistor at B+ is not necessary, like in CR719M, CR719N and CR719P.

2. Available variants

The CR719 Regulator IC is available in different preconfigured variant configurations to meet different OEM requirements.
The difference between these variants is listed in following table:

		CR719P	CR719K	CR719M	CR719N
Regulating voltage	V_{REG}	14.55	14.55	14.55	14.25
Temperature coefficient [mV/K]	TCO	–10	–10	–10	–3.5
Start rotational speed [rpm]	n_{START}	1470	1470	1840	1470
Wait time [sec] (idle time after n_0, see Figure 3)	t_V	0.4	0.4	0.0	2.5
Load response ramp (time 0→100%) [sec]	t_{LR}	2.56	2.56	10.2	6.8
Load response cut-off speed [rpm]	n_{LR}	3000	3000	3600	always active
Self-start rotational speed [rpm]	n_{SELF}	4230	4230	4230	1470
Alternator pole pairs	PP	6	8	6	6
DFM driver configuration (see Figure 1)		low-side	push-pull	low-side	low-side

Ordering information	Delivery form	Part no.
CR719P	MW8	0272 240 101
	Bare die	1277 127 976
CR719K	MW8	0272 240 079
CR719M	MW8	0272 240 081
CR719N	MW8	0272 240 084

3. Maximum Ratings

All operational voltages related to ground, positive current flowing into pin.
Variants of CR719 are CR719K, M, N and P. Unless otherwise specified, parameters are valid for all.

Item	Parameter	Condition	Symbol	Min.	Max.	Unit
5	Storage temperature	Case temperature	T_c	–55	160	°C
	Junction temperature	Internal chip temperature	T_J	–40	155	°C
	Operating temperature	Life time	T_c	–40	140	°C
		Short time, max. 15min. and <5% of life time	T_c		150	°C
	Overvoltage	In standby ($V_L \leq V_{B+}$)	V_{B+} V_v V_{DFM} V_L		32	V
	Overvoltage at Load Dump <400ms ($V_L \leq V_{B+}$)	Test condition: • field coil 1.5 Ohm at RT • lamp 4.2W/12V • DFM pull up 800Ω	V_{B+} V_{PH} V_{DF} V_L		37	V
			V_{DFM}		42	V
	Negative voltage, regulator built in alternator	<2s	V_{B+}	–2		V
			V_v	–2		V
		Test condition: • lamp 4.2W/12V • DFM pull up 800Ω	V_L V_{DFM}	–1		V
	Lamp current		I_L		0.5	A
	Lamp power dissipation		P_L		5	W
	Relay current	w/o freewheeling diode (lamp driver is used as freewheeling circuit)	I_L		–0.5	A
		With external freewheeling diode	I_L	–0.5	–1	A
	ESD	HBM, R=1.5kΩ, C=100pF	V_{DFM}	–2	2	kV
			All other pins	–8	8	kV

4. Parameters

Variants of CR719 are CR719K, M, N and P. Unless otherwise specified, parameters are valid for all.

GTA (General test application):
Unless otherwise specified, following test application is valid: V_{B+}=13.5V, V_{DF} with 220Ohm to GND, L with 220Ohm to B+, sine half-wave at V-terminal, (0–14V, f=600Hz), Tc=25°C

B+ Terminal (Battery)								
Item	**Parameter**	**Condition / Remark**		**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
6.3.1	Standby current	V&L open, Tc<80°C		I_{B+}	60	190	300	µA
6.3.2	On current	V, DF, DFM open		I_{B+}	5	10	30	mA
6.3.5	Operating voltage range			V_{B+}	7.5		24	V
6.3.6	Restricted operating range	No short circuit protection in this range		V_{B+}	4		7.5	
6.3.7	Switch on field power stage	Under voltage at B+		V_{B+}	5.5	6	6.5	
6.3.8	Switch off field power stage	Over voltage at B+		V_{B+}	24	27.6	30	
6.3.9		Hysteresis		Hyst		1.5		
7.1 7.3 7.5	Regulating voltage	CR719 K,M,P	25°C	V_{REG}	14.4	14.55	14.7	
			140°C		13.3	13.45	13.6	
		CR719 N	25°C		14.1	14.25	14.4	
7.4			140°C		13.76	13.91	14.06	
7.1 7.3 7.5 7.4	Temperature compensation	CR719 K,M,P		TCO	–12	–10	–8	mV/K
		CR719 N			–5.5	–3.5	–1.5	
7	High temperature ramp down	Threshold		T_{HTRD}	147	152	157	°C
6.4.4		Steepness		TCO_{HT}		–250		mV/K
7	Voltage limitation	Tc = –40...140°C		V_{LIMIT}		14.9		V
7	Threshold low voltage function			V_{LOW}		12		V

DF Terminal (field driver)							
Item	**Parameter**	**Condition / Remark**	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
6.6.4	Field driver on resistance	V_{B+}=13V, T_C=–30°C, I_{DF}=–6A	R_{ON}		50	90	mΩ
6.6.5		V_{B+}=13V, T_C=25°C, I_{DF}=–4.5A			60	90	
6.6.6		V_{B+}=13V, T_C=140°C, I_{DF}=–3.3A			100	143	
6.6.8	Freewheeling diode forward voltage	T_C=–30°C, I_{DF}=6A	V_F			–1.6	V
6.6.9		T_C=25°C, I_{DF}=6A			–1.1	–1.6	
6.6.10		T_C=140°C, I_{DF}=4.3A			–1	–1.4	

6.6.13	Field driver OFF threshold	B+=16V (see 5.9.3 Error indication)	V_{DF_OT}	0.4	1.3	2.1	V
6.6.25	Field driver self-protection threshold	T_C=–40°C	I_{DF_Lim}	8.7	10.5		A
		T_C=25°C		8.2	10		
		T_C=140°C		7.3	9.1		

Regulation Parameter							
Item	**Parameter**	**Condition / Remark**	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
7	Alternator pole pair number	CR719P,M,N	PP		6		
		CR719K			8		
6.6.14	Pre-excitation frequency	T_C=–40°C	f_{PRE}	30	37.5	41.25	Hz
		T_C= 25°C T_C= 140°C		33.75	37.5	41.25	
6.6.18	Pre-excitation duty cycle	V_{B+}<V_{REG}	DC_{PRE}	20	25	30	%
6.6.19		V_{B+}>V_{REG}	DC_{PRE_2}	7	8.5	10	
6.6.15	Regulation frequency	T_C= –40°C	f_{REG}	120	150	165	Hz
6.6.16		T_C= 25°C T_C= 140°C		135	150	165	
7	Rotational speed detection threshold		n_0	460	580	630	rpm
6.5.2	Filter time for n_0		n_{0_FILT}		50		ms
7	Start speed (normal start)	CR719 P,K,N	n_{START}	1300	1470	1620	rpm
		CR719 M		1620	1840	2030	
7	Wait time (after start-up)	CR719 P	t_V		0.4		s
		CR719 K			2.1		
		CR719 M			0		
		CR719 N			2.5		
6.10.11	Phase hold voltage	Low phase voltage value to hold alternator active	V_{V_HV}	9.7	10.2	10.7	V
7	Load response ramp (Duty Cycle 0 to 100%)	CR719 P,K	t_{LR} (g_{LR})		2.56 (39)		s (%/s)
		CR719 M			10.2 (9.8)		
		CR719 N			6.8 (14.6)		
7	Load response cut-off speed	CR719 P,K	n_{LR}	2700	3000	3440	rpm
		CR719 M		3240	3600	4170	
		CR719 N			always active		

7	Duty Cycle regulation speed (when LR Off)		g_{MAX}		230		%/s
6.5.5	LR filter time		t_{LR_FILT}		300		ms
7	Self-start speed (L disconnected)	CR719 P,K,M	n_{SELF}	3600	4230	4660	rpm
		CR719 N		1300	1470	1620	
6.1.6 6.7.21 6.7.20	Shut down time	Filter time to enter standby mode	t_{SD}		57		ms

V Terminal (phase signal input)							
Item	**Parameter**	**Condition / Remark**	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
6.10.1	Current consumption	V_V=14VDC, L=open	I_{V_IN}	0.2	0.45	0.7	mA
6.10.2		V_V=14VDC		2.8	9	15	
6.10.5	Minimum voltage threshold to enter self-start mode (linked with V_{V_SPP})	L=open, sine at V, freq=400Hz, Tc=–40 to 125°C	V_{V_SELF}	0.6	1.45	2.5	V
6.10.6	Minimum amplitude to enter self-start mode (linked with V_{V_SELF})	L=open (peak-peak value)	V_{V_SPP}	0.9	1.2	1.5	
6.10.7	Minimum amplitude to enter normal-start mode	(peak-peak value, see chapter 5.10)	V_{V_PP}	2.1	2.45	3	V
6.10.8	DC-scope for frequency evaluation	(see chapter 5.10)	V_{V_DC}	0		8	V
6.10.9	Low voltage threshold for fault signalization at L		V_{V_LV}	7.8	8.3	8.8	V

L Terminal (lamp and relay driver)							
Item	**Parameter**	**Condition / Remark**	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
6.7.2	Minimum current for switch on lamp driver	V=open, Clamp V_L=1.3V	I_{L_ON}	0.7	1.8	2.5	mA
6.7.3	Switch off threshold, detection “Ignition off”	V=open, TC= –40...50°C	V_{L_OFF}	0.6	0.8	1.1	V
6.7.4		V=open, TC= 50...140°C		0.5	0.7	1.0	
6.7.5	Voltage drop lamp driver	V=open, I_L=5mA...500mA	V_{L_ON}	0.95	1.2	1.5	V
6.7.17	Delay time error indication	V_{B+}=16V, DF=B+	t_{L_ERR}	40	50	60	ms
6.7.6	Lamp driver overcurrent shut off (see also t_{L_SP1}, t_{L_SP2})	V=open, V_L=2V	I_{L_LIMIT}	0.5	1.4	1.8	A
6.7.9	Voltage drop relay driver	I_L=–0.5A	V_{REL_DR}	0.05	0.2	0.6	V
6.7.10		I_L=–1A		0.1	0.4	1.1	V

6.7.11	Relay driver overcurrent shut off (see also t_{L_SP1}, t_{L_SP2})	V_{B+} to V_L=2V	I_{R_LIMIT}	–1.1	–2.1	–2.8	A
6.7.18	Delay time for overcurrent protection (lamp and relay driver)	delay time for switch off	t_{L_SP1}		50		ms
6.7.19		delay time for reactivation	t_{L_SP2}		200		ms

DFM Terminal (field monitor)							
Item	**Parameter**	**Condition / Remark**	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
2.3.4	Frequency				150		Hz
6.8.2	Voltage drop low side driver	LS-driver On, I_{DFM}=20mA	V_{DFM_LS}	50	530	1400	mV
6.8.3	Voltage drop high side driver	HS-driver On, I_{DFM}=20mA	V_{DFM_HS}	0.5	1.8	2.5	V
6.8.4	Current limitation DFM low side	LS-driver On, V_{DFM}=3V	I_{DFM_LLS}	21	35	70	mA
6.8.5	Current limitation DFM high side	HS-driver On, V_{DFM}=3V	I_{DFM_LHS}	–70	–32	–21	mA
6.8.6	Current consumption DFM low side	Standby-mode, B+=32V, V_{DFM}=32V	I_{DFM_LS}	–110	0	110	µA
6.8.7	Current consumption DFM high side	Standby-mode, B+=32V, V_{DFM}=0V	I_{DFM_HS}	–110	0	110	µA
Data word output							
6.9.4	Delay time before sending data word	After power on reset After wake up via terminal L After self-start via terminal V	t_{DW1}		500		µs
6.9.5	Logic 0	Duty cycle bit coding for low value	DC_0	10	25	40	%
6.9.6	Logic 1	Duty cycle bit coding for high value	DC_1	60	75	90	%
6.9.7	Bit time		t_{BIT}		208		µs
6.9.8	Data word length		n_{DW}		69		Bit
6.9.9	Delay time after data word output	DFM=High	t_{DW2}		50		µs
Acceleration mode - Filter times and factors during acceleration mode							
6.11.1	acceleration mode threshold (voltage threshold to activate acc. mode)	external serial resistor for current limitation (2kOhm) at DFM terminal necessary	V_{ACC}	31	35	39	V
6.12.1	Delay time for error indication	(see t_{L_ERR})	factor		64		
6.12.2	Delay time for overcurrent protection	(see t_{L_SP1}, t_{L_SP2})	factor		128		
6.12.3	Wait time (after start-up)	(see t_v)	factor		128		
6.12.5	Filter times for speed evaluation	(see n_{START}, n_{LR}, n_{SELF})	factor		256		
6.12.6	Load response ramp	Set to maximum (see also g_{MAX})	g_{LR_acc}		230		%/s

5. Regulator Functions

5.1 Regulator state machine

Here is shown the principle states of the regulator. These are described in detail in the following chapters.

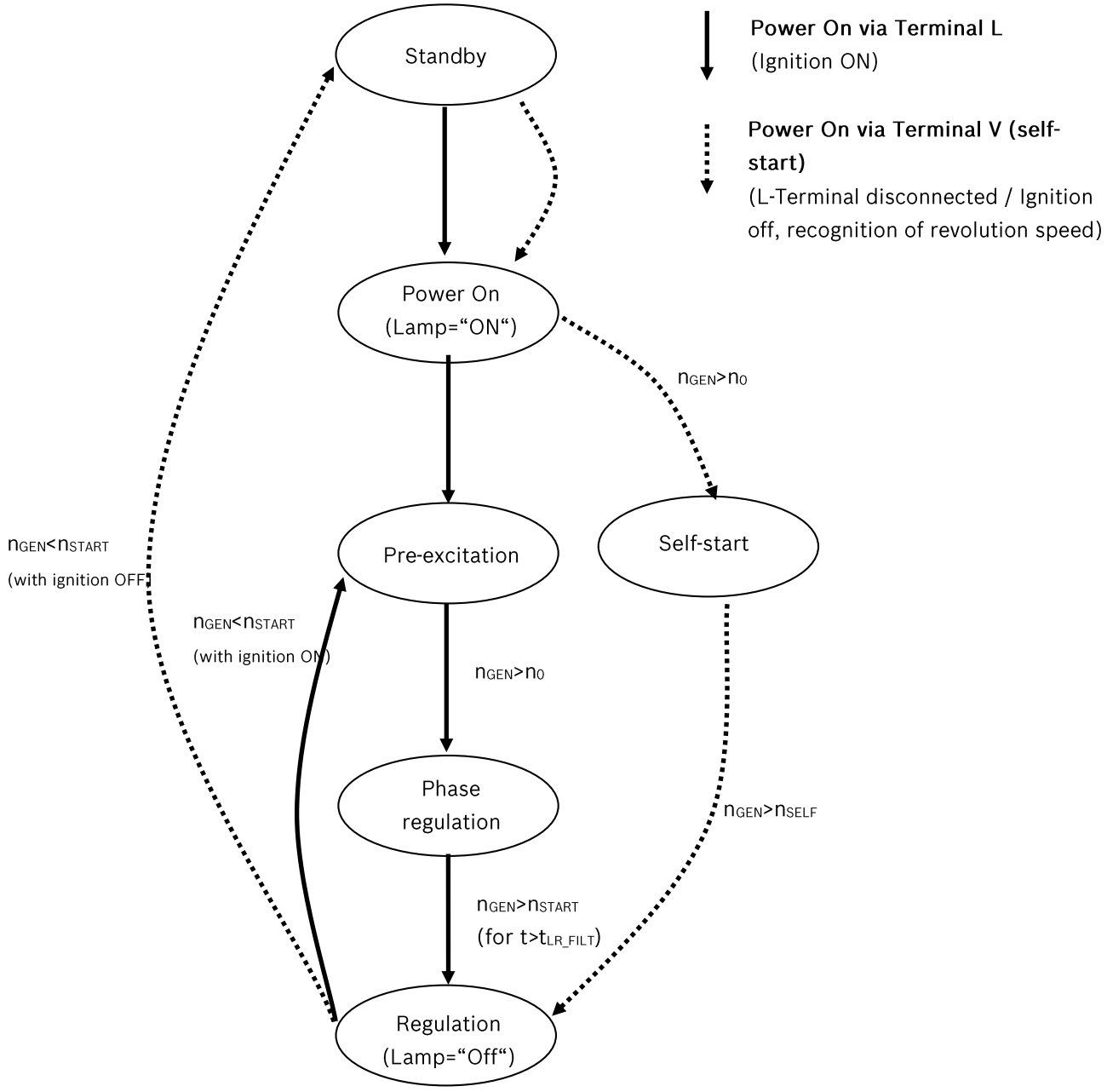


Figure 2 Regulator state machine

5.2 Normal start procedure

With the ignition switched on, the L terminal is connected to the battery via the lamp. This voltage at L is the signal for the regulator that the engine is about to start (high level at L terminal → “Ignition ON”).

The regulator turns on the lamp by activating the lamp driver T1. The relay driver T2 stays off.
Furthermore, the regulator starts pulsing the output stage with a fixed frequency and constant duty cycle DC_{PRE} (pre-excitation pulsing). The resulting pre-excitation current induces a voltage in the stator and in the phase connection of the regulator respectively, as soon as the alternator starts rotating.

The regulator determines the alternator rotational speed from a frequency evaluation of the phase signal.
As soon as the information “alternator running” ($n_{GEN} > n_0$) is detected, it switches from pre-excitation mode to phase voltage regulation mode.

In this mode, start speed is considered to be reached if $n_{GEN} > n_{START}$ for more than t_{LR_FILT} seconds (see Figure 3). Then the lamp driver T1 turns off the lamp and relay driver T2 is switched on.

For a smooth start up, the regulator is regulating at first the phase voltage from a very low value V_{V_LV} up to V_{V_HV} before entering the normal load response ramp (see Figure 3).

Due to this start up strategy there is no additional torque load from the alternator during engine start.

Note:
During phase regulation, before set value regulation, the load response cut-off speed threshold n_{LR} is not active (see chapter *6.5 Load response cut-off speed*).

To keep the regulator active (especially if there is no phase signal) and to ensure a normal start procedure in case of a reset, the L terminal voltage must be kept to high level constantly.

If during the start procedure the voltage at L drops below V_{L_OFF} (“Ignition OFF” level) and the evaluation of the start rotational speed is not finished yet, the regulator will only start by self-start function.

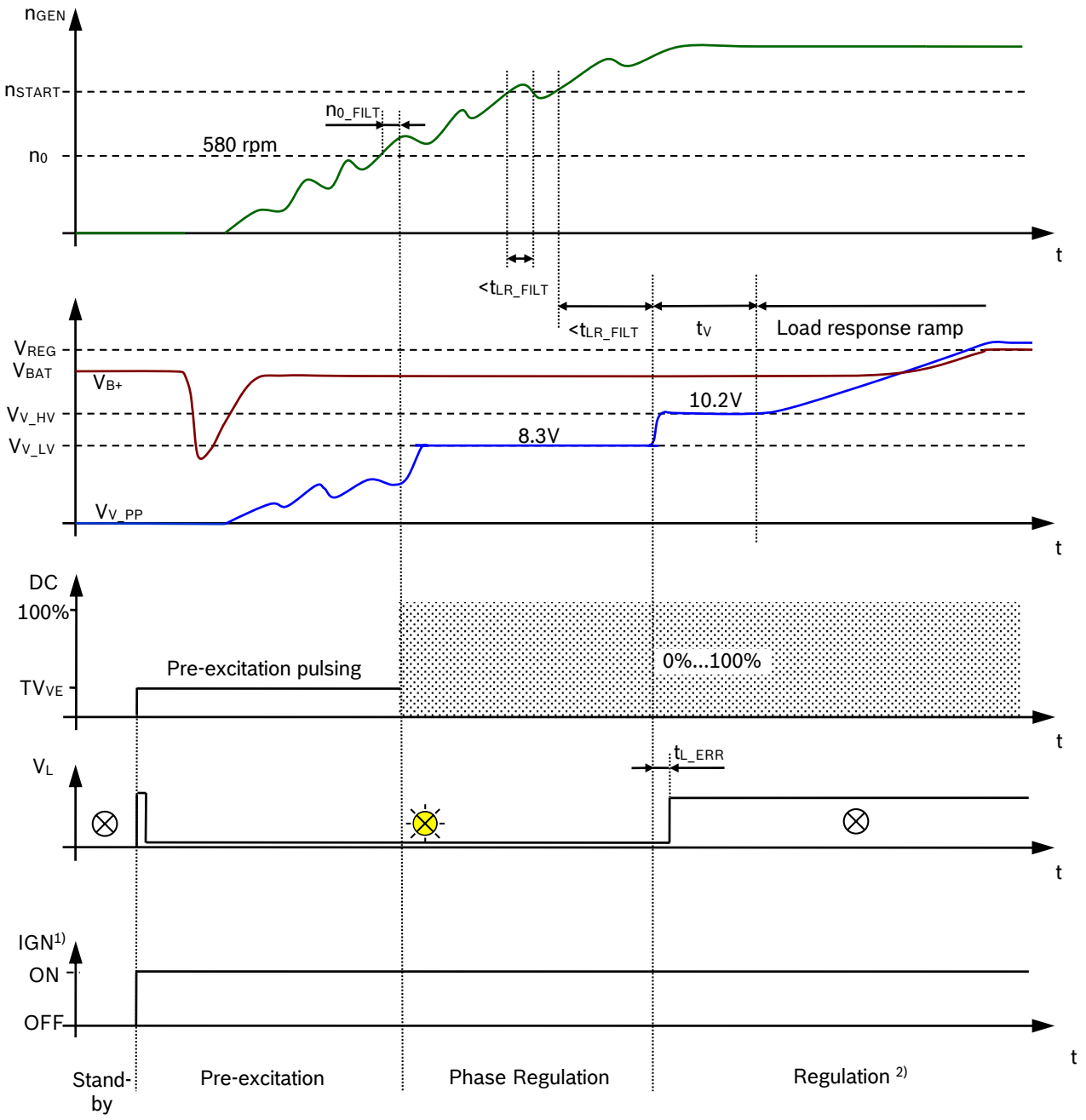


Figure 3 Normal start procedure

1) Input level at L-terminal of CR719, depending of e.g. ignition switch

2) Voltage ramp-up according t_V and load-response setup

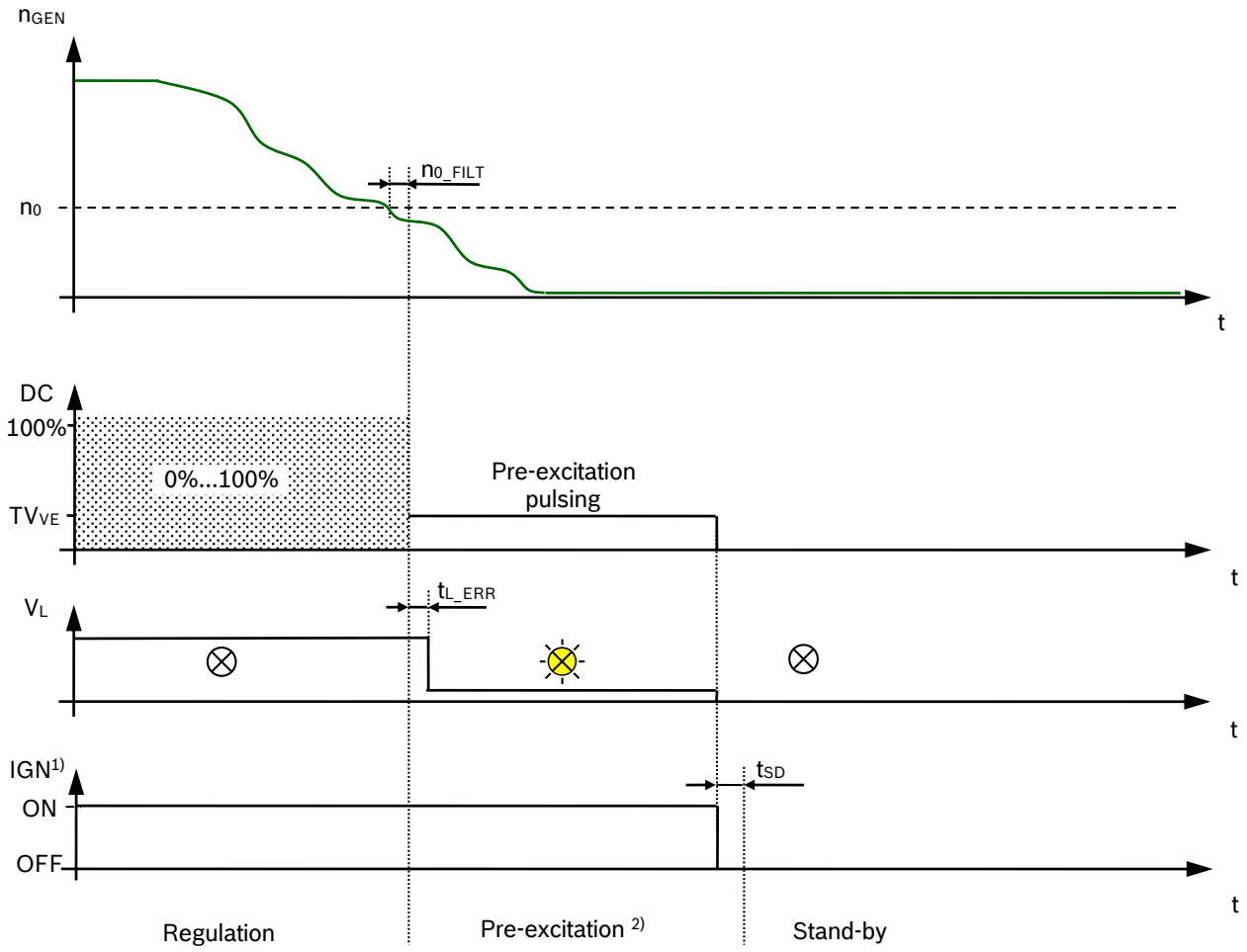


Figure 4 Shut-down case 1

1) Input level at L-terminal of CR719, depending of e.g. ignition switch

2) To return to Regulation-mode directly from Pre-excitation, see normal start procedure

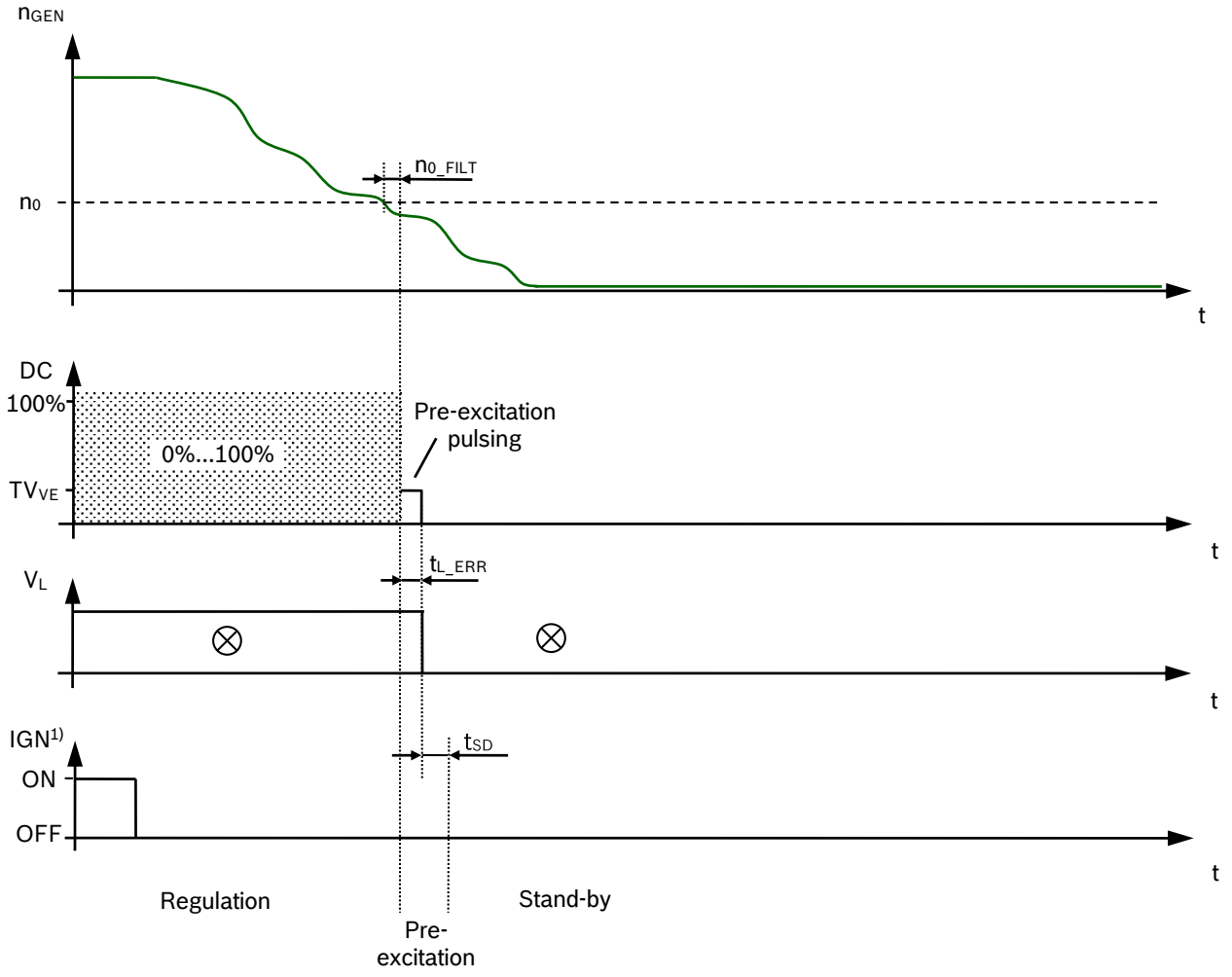


Figure 5 Shut-down case 2

[1)] Input level at L-terminal of CR719, depending of e.g. ignition switch

5.3 Self-start

In case of missing signal at L-terminal, the regulator will be activated after detection of a phase signal induced by remanence of the rotor. The regulator will switch to normal start procedure mode (see chapter 5.2) if the self-start speed was recognized ($n_{GEN}>n_{SELF}$).

The regulator parameters (regulation set voltage, load response parameter) remain the same as in normal operation.
The start rotational speed at self-start depends on the remanence of the rotor and the dynamic of the alternator, however n_{SELF} has to be exceeded.
The self-start function is always active, thus the regulator will return again to standby mode when the rotational speed falls below self-start speed ($n_{GEN}<n_{SELF}$).

5.4 Load response function

The regulation process (e.g. in case of load switching-on) can cause an abrupt increase of the alternator torque.
This may lead to variation of the engine rotational speed, especially at idle mode.

The load response function limits the control rate of the regulator by reduction of the duty cycle rise rate. This results in a slower increase of the excitation current and thereby of the alternator torque (see Figure 6). These comparatively slow variations of the torque can be compensated by the engine management or engine controller.

The rise rate of the duty cycle is defined by the load response ramp time t_{LR}. The ramp time indicates the time in which the duty cycle is theoretically increased from 0% to 100% (see Figure 6).
Alternatively, the gradient g_{LR} of the ramp can be specified as well in percentage per second [%/s].

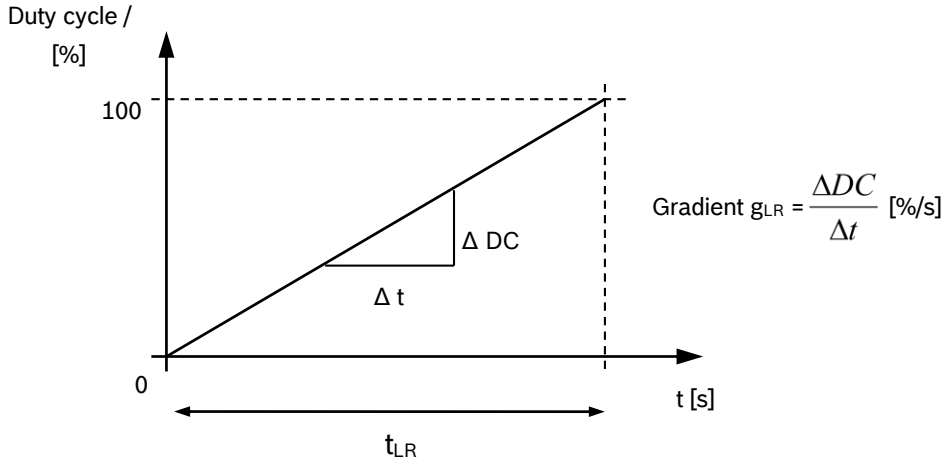


Figure 6 Definition of load response ramp time and gradient

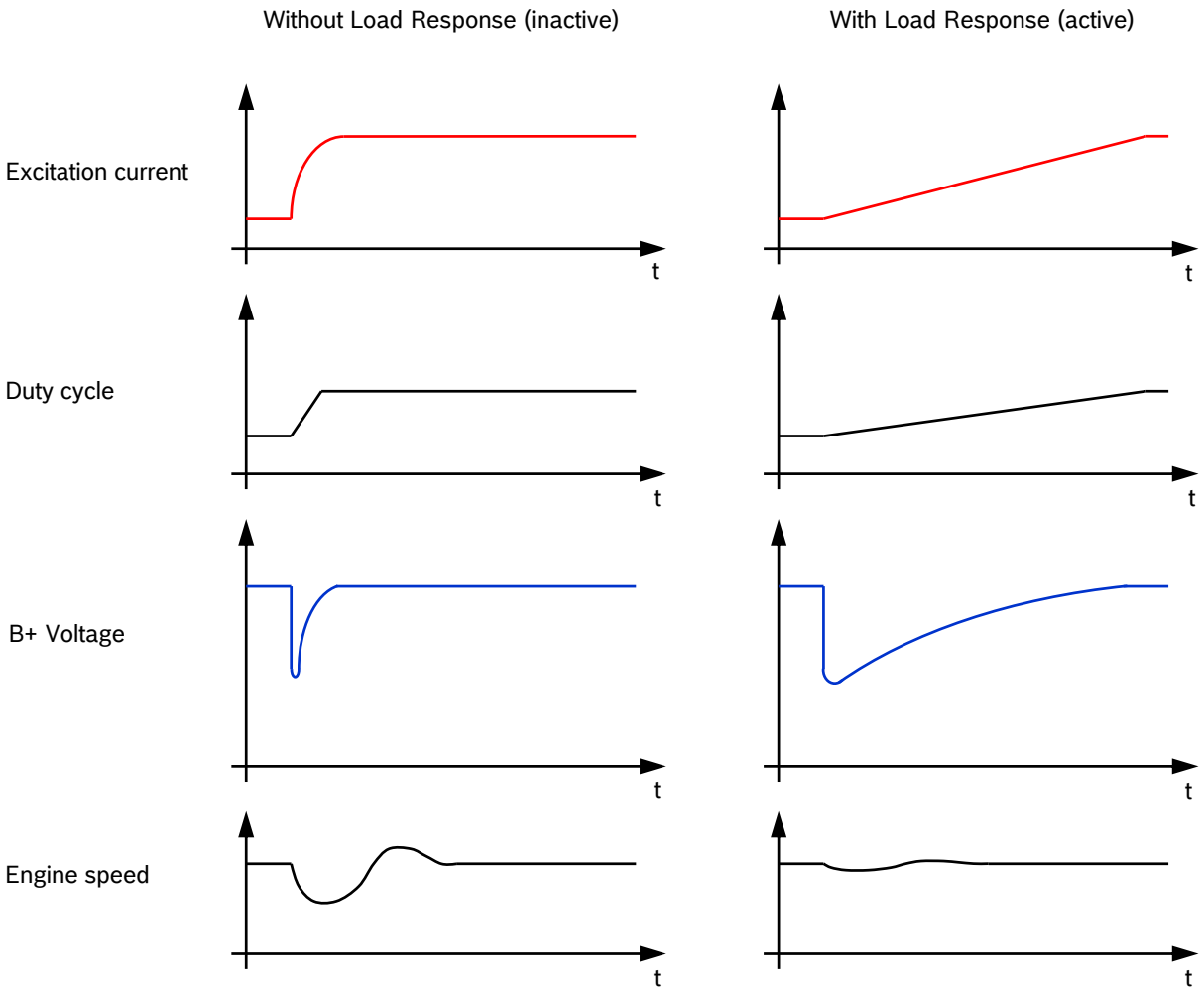


Figure 7 Load switching on w/ and w/o load response

5.5 Load response cut-off speed

The load response function is active while the alternator speed n is below the load response cut-off speed n_{LR} ($n_{GEN}<n_{LR}$).
If the speed falls below the speed threshold n_{LR}, the function will be activated after a buffer time of t_{LR_FILT}. If the speed exceeds n_{LR}, the function will be deactivated instantaneously (see Figure 8).
The load response cut-off speed is ignored during the start procedure, thus the load response function stays always active during start (see chapter 5.2 Normal start procedure).

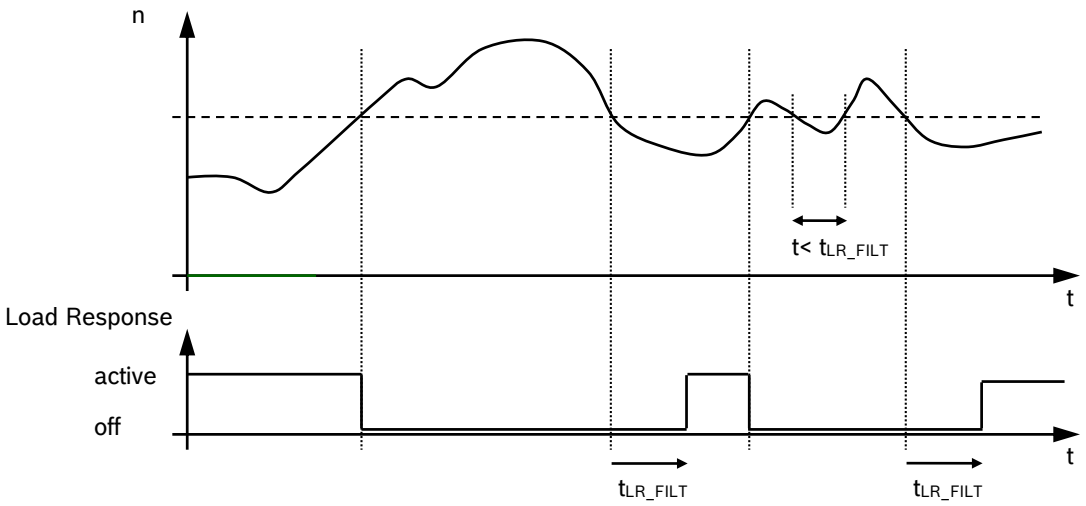


Figure 8 activation and deactivation of load response function

5.6 Low voltage function

In case of high electrical load switching-on, especially with discharged or defective battery, the voltage of the power supply can drop to low values. If the voltage falls under the minimum operating voltage, the generator can de-energise especially if no battery is connected.

The duration of the voltage drop can be minimized by fast regulation (instantaneous switching-on of output stage). The threshold for low voltage is V_{LOW}, i.e. there will be a fast regulation below this limit even if load response function is active (see Figure 9).

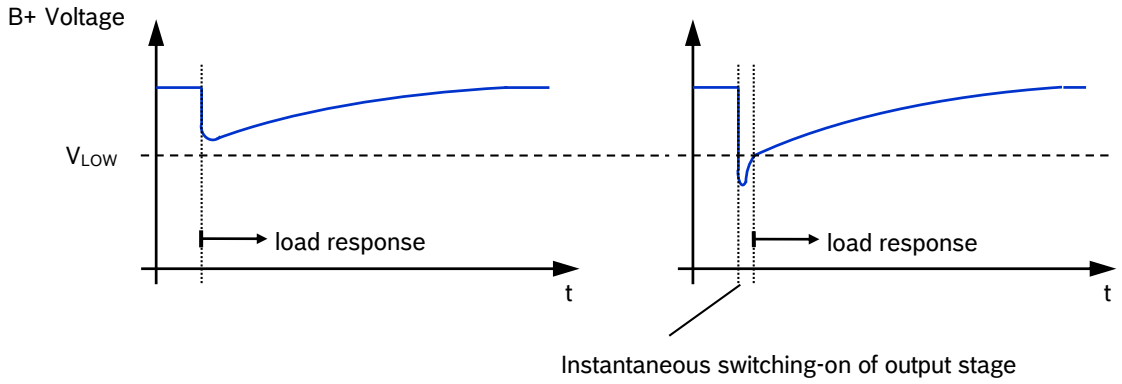


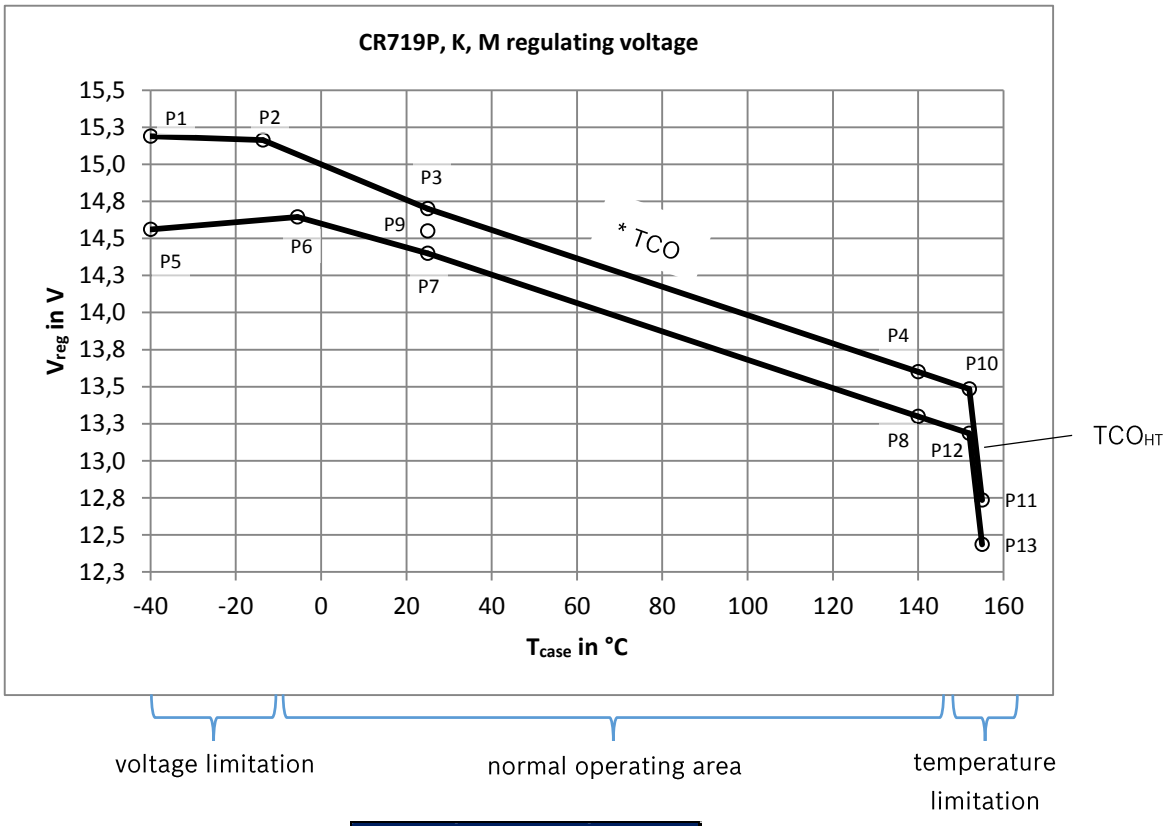
Figure 9 Low voltage function

5.7 Phase regulation function

Overvoltage, for example caused by load switching or load dump, leads to immediate switch-off of the output stage. To avoid in this case a complete de-energizing of the generator, the phase voltage will be regulated to internal minimum level to prevent a switching-on of the lamp. This function also allows a fast return to the normal set value when the overvoltage event is over.

5.8 Temperature compensation

To adapt the output voltage to the optimal battery charging voltage, the regulation voltage is reduced if the temperature increases.
The temperature coefficient TCO specifies the ramp steepness of the voltage reduction (see Figure 1Figure 10).
To avoid too high voltages at low temperatures, an additional limitation to V_{LIMIT} is implemented.
The regulator measures the temperature T_C (case temperature) on the ASIC. For thermal protection of the regulator, the regulated voltage will be reduced with a defined ramp TCO_{HT} if the high temperature ramp down threshold T_{HTRD} is exceeded.



Point	Tcase [°C]	Vreg [V]
P1	-40.00	15.19
P2	-13.64	15.16
P3	25.00	14.70
P4	140.00	13.60
P5	-40.00	14.56
P6	-5.56	14.64
P7	25.00	14.40
P8	140.00	13.30
P9	25.00	14.55
P10	152.00	13.49
P11	155.00	12.74
P12	152.00	13.19
P13	155.00	12.44

Figure 10 Voltage regulation over temperature. Voltage regulation with 20% Duty Cycle, GTA, Graphic shows example for CR719P K, M-Variant; V_{REG}=14.55V and TCO=–10mV/K

5.9 L Terminal

5.9.1 Lamp driver

For detection of “Ignition ON”, the voltage level at L must be higher than the switch off threshold V_{L_OFF}.
To provide a high robustness against external disturbances, in addition to the minimum voltage level, a minimum current of I_{L_ON} is required to switch on the lamp driver.

The regulator will change from standby into regulation mode after activation and detection of the corresponding rotational speed thresholds. In this mode the lamp driver will switch off and the relay driver will switch on (see chapter 5.2 Normal start procedure and 5.9.2 Relay driver).
If the lamp level falls below the activation threshold V_{L_OFF} the regulator detects “Ignition OFF”. It turns to standby mode or stays in regulation mode if a valid phase signal ($n_{GEN}>n_0$) is detected (see also chapter 5.3 Self-start).

The L-terminal is designed with a short circuit protection. This protection is only active if the supply voltage is applied to the regulator (B+ terminal). The L-terminal must not be continuously shorted to ground in the application

Note:
Slight difference in voltage levels on L and B+ -terminals (e.g. due to resistive wiring) can cause the lamp to glow.

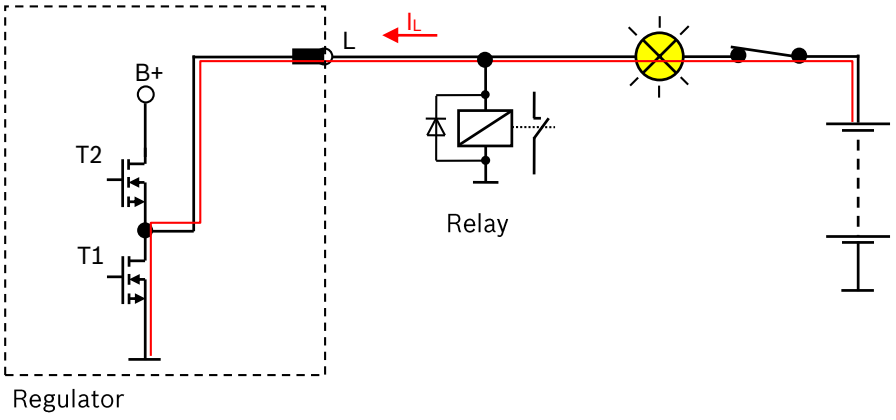


Figure 11 Lamp driver circuit

5.9.2 Relay driver

During the start procedure the lamp is on (T1=on, T2=off, see Figure 11).
As soon as the start speed n_{START} is reached, T1 and T2 are switched, i.e. T1 will be switched off and T2 will be switched on. This turns off the lamp and an optional external relay is activated (see Figure 12 Relay driver circuit).
The relay can be used to switch external loads which should not be active during the start procedure.
The activation of the lamp by the regulator in case of an error turns the relay off.

It is recommended to connect a freewheeling diode to the relay (see also specification of I_L in chapter 3 Maximum Ratings).
Without external diode the transistor T1 acts as freewheeling circuit.

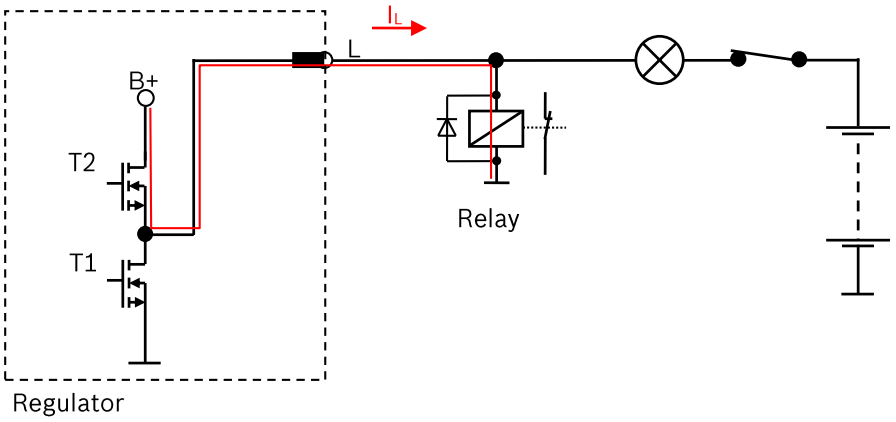


Figure 12 Relay driver circuit

5.9.3 Error indication

The following errors will be indicated by switching on the lamp driver. In this case, the relay driver will be switched off. The error has to be present for a minimum filter time with at least t_{L_ERR} before lamp driver will switch on.
Errors will not be stored.

Error	Condition / Remark
Low voltage	DC = 100% AND $V_V < V_{V\_LV}$
Low generator speed	$n_{GEN} < n_0$ OR $V_V <$ evaluation threshold (see V_{V_SELF}, V_{V_SPP}, V_{V_PP})
Short circuit DF to B+	Field driver off AND $V_V > V_{DF\_OT}$
Short circuit DF to GND	Leads to “low voltage” error
Open circuit at DF	Leads to “low voltage” error
Open circuit at phase	Leads to “low generator speed” error
Open circuit at B+	Lamp driver turns on also if no B+ terminal is connected

5.10 V terminal

Normal start (wake up via L terminal)
The regulator will enter the phase regulation mode, at first regulating the phase voltage to a low level of V_{V_LV}. The phase frequency (generator speed) will be evaluated between the ranges 0V to V_{V_DC} (0 ... 8V). The AC-peak amplitude threshold is V_{V_PP}. Hence, all AC-voltages below this threshold will not be evaluated.

Self-start (when L is disconnected)
For higher sensitivity the AC-peak amplitude threshold is switched internally to a lower value V_{V_SPP}. After the phase voltage reached this threshold, the regulator enters the self-start mode. As soon as the self-start threshold V_{V_SELF} is reached, the regulator enters the normal regulation mode.

The evaluation of the phase signal V_V is done by amplitude and frequency detection. As soon as the threshold level V_{V_PP} or V_{V_SPP} (if L connected or not) is exceed, the phase signal frequency will be evaluated.

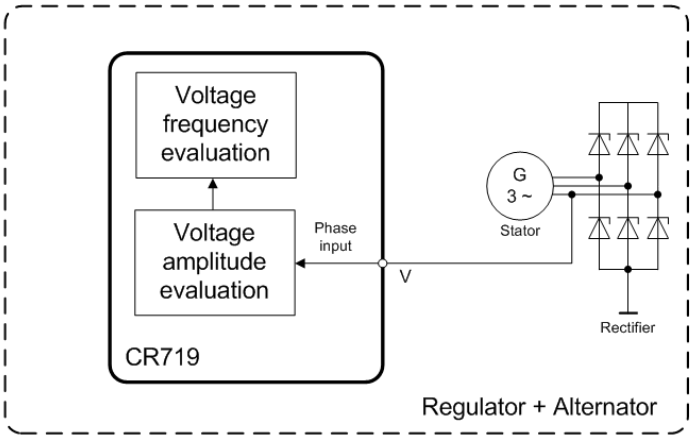
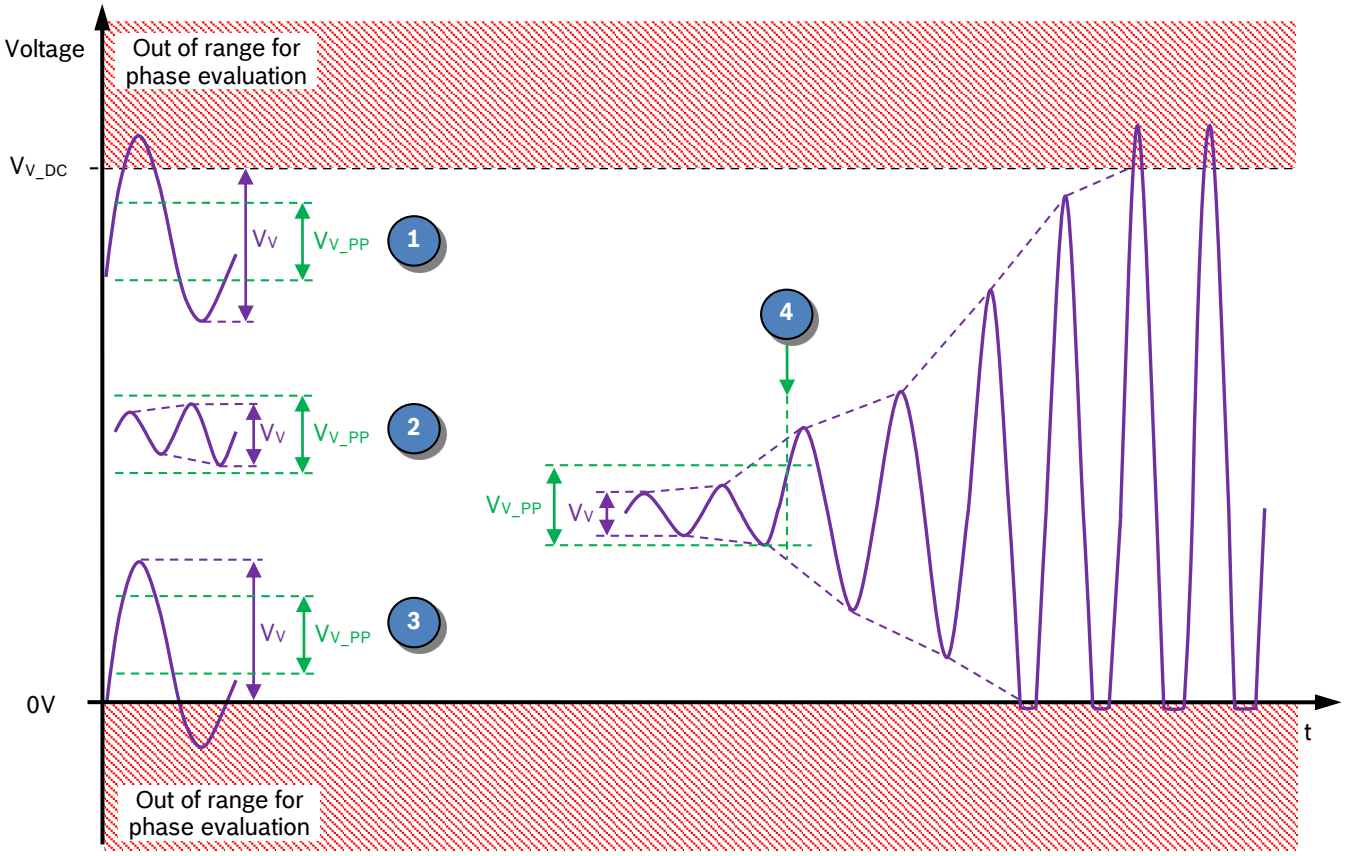


Figure 13 Phase sensing block diagram

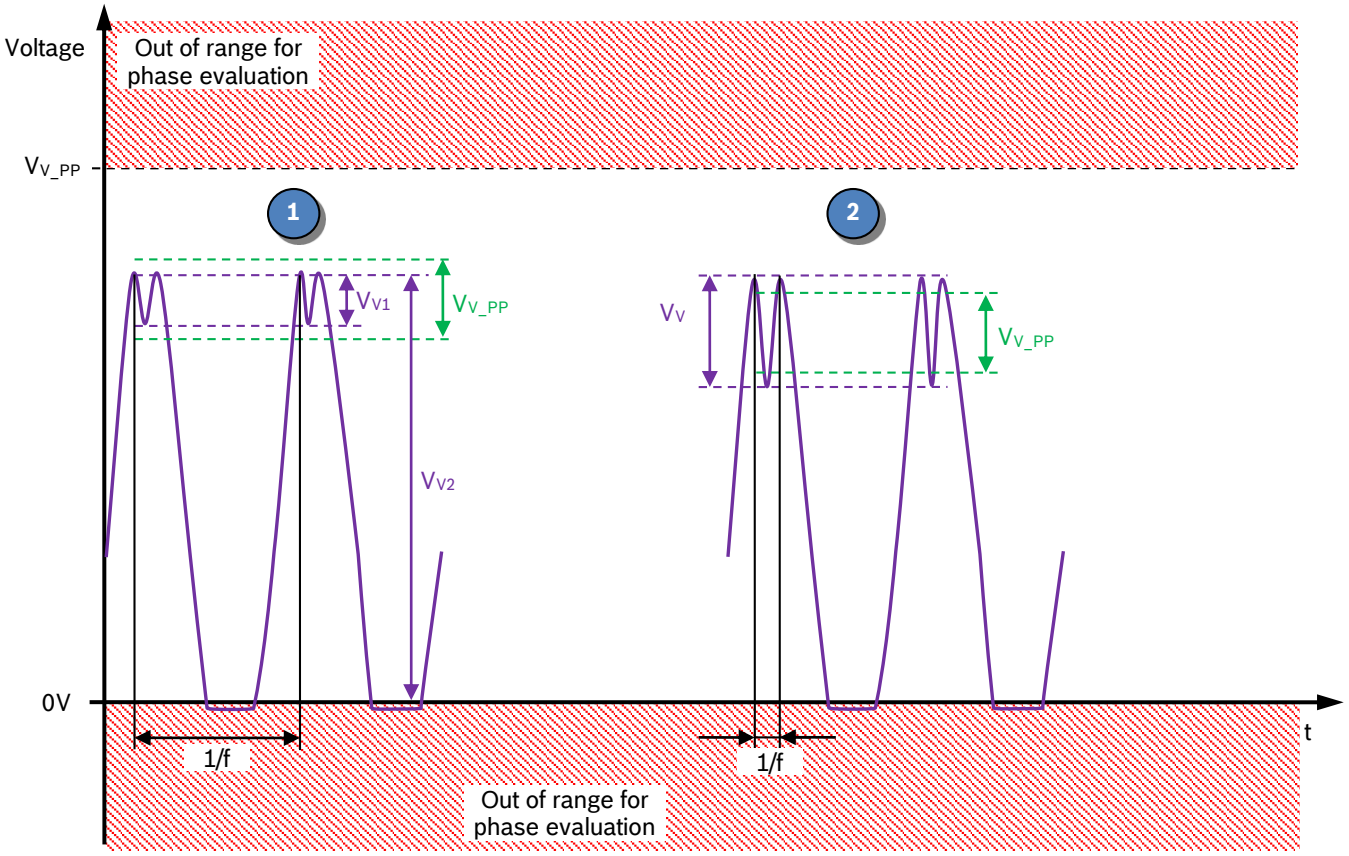
5.10.1 Amplitude evaluation



1. Phase voltage V_V > phase threshold V_{V_PP} → Phase signal will be evaluated.
   The voltage signal which exceeds the upper phase level U_{V_DC} will not be recognized.
2. Phase voltage V_V < phase threshold V_{V_PP} → Phase signal will <u>not</u> be evaluated.
3. Phase voltage V_V > phase threshold V_{V_PP} → Phase signal will be evaluated.
   The voltage signal below the lower phase level of 0V will not be recognized.
4. Point of time when the phase voltage V_V exceeds the phase threshold V_{V_PP}
   → at this time phase signal evaluation starts.

Figure 14 Phase voltage - example of amplitude evaluation

5.10.2 Frequency evaluation



1 Phase voltage ripple V_{V1} < phase threshold V_{V_PP} → Ripple will not be evaluated.
Phase voltage V_{V2} > phase threshold V_{V_PP} → Phase frequency evaluation is correct

2 Phase voltage ripple V_V > phase threshold V_{V_PP} →The ripple will be evaluated as phase signal frequency → wrong phase frequency evaluation

Figure 15 Phase voltage - example of frequency evaluation

5.11 DFM terminal

The DFM pulse width modulated output signal represents the duty cycle (generator load from 0%...100%) of the output stage. It can be used by the ECU to monitor the alternator.
The phase orientation (inverted to output stage) is shown in Figure 16.
In the CR719K variant the DFM driver is a push-pull stage. For the low-side driver variants CR719M, CR719N and CR719P, a pull up resistor has to be connected (see also Figure 1 Application diagram).

The maximum allowed current into the DFM-terminal has to be considered according I_{DFM_LIM}.

The DFM-terminal is designed with a short circuit protection. The short circuit protection is only active if the supply voltage is applied to the regulator at B+ terminal.

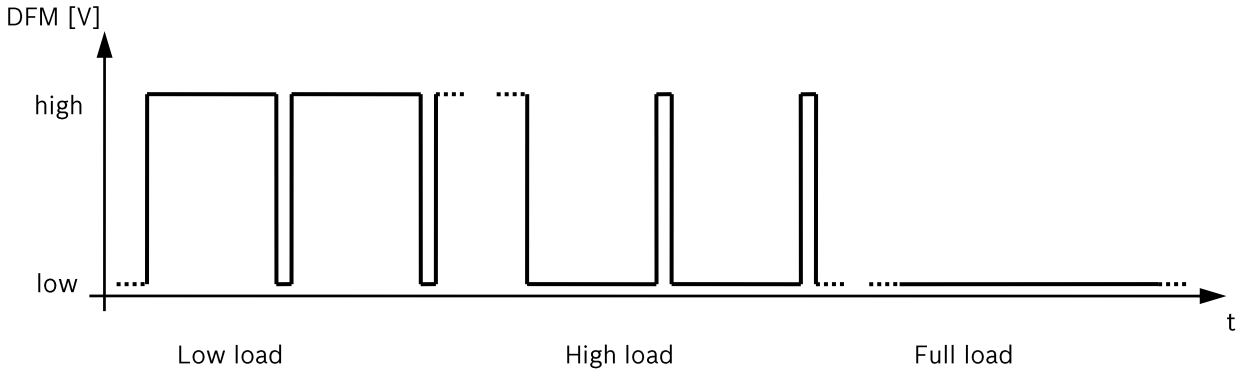


Figure 16 Phase orientation for the DFM signal

5.11.1 Test acceleration mode

To enter test acceleration mode at regulator manufacturing, the DFM terminal has to be connected to a current limited voltage source that is higher than the test acceleration threshold voltage V_{ACC} (e.g. 40V via a 2kOhm serial resistor). The IC will detect this external voltage when it tries to drive the DFM output high.

Example:

- apply B+ voltage (e.g. 13V)
- apply 40V via 2kOhm resistor to DFM
- close the ignition switch
- wait for the DFM signal to be driven high
    - a power-on reset will be performed
    - test acceleration mode will be activated

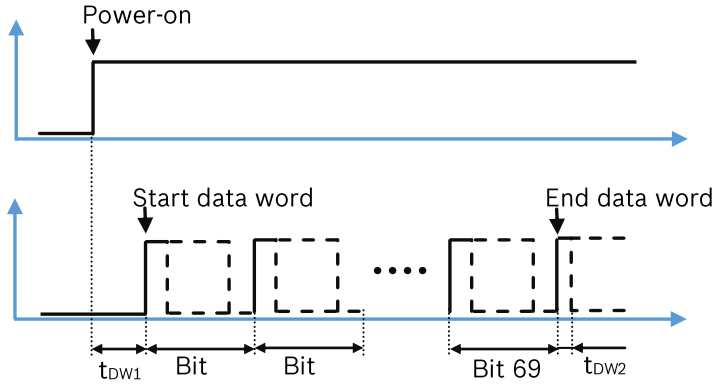
In test acceleration mode, the following functional effects are active:

- acceleration of time based processes according acceleration factor (see chapter 4 Parameters acceleration mode)
- DFM-driver will be deactivated and set to tristate

The regulator will return to normal mode when the voltage applied to the DFM terminal falls below the threshold V_{ACC} (e.g. <31V).

5.11.2 Data word

After power-on reset, a data word will be send on terminal DFM which can be used for identifying the respective chip variant (CR719K, M, N, P). The data word is sent as a PWM (pulse width modulated) signal with a fix bit time t_{BIT} and a defined minimum and maximum duty cycle DC_0, DC_1 which allows a slope triggered evaluation.
It contains 9 address-bytes (Addr. 0 to 8) with a total of 69 bits. Addresses 0-7 are each 8 bit long, address 8 is 5 bit long. The first bit (Bit 1) is address 0 Bit 2^0, the last one Address 8 Bit 2^4 (Bit 69).



For identification, the data word can be masked according to the following tables:
x = don't care (can be 1 or 0)
0 = Logic "0"
1 = Logic "1"
-- = Not sent

5.11.2.1Data word coding

Dataword coding CR719K								
Addr	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
0	1	1	x	x	x	x	x	x
1	1	0	0	0	x	x	x	x
2	x	x	x	0	0	0	0	0
3	0	0	1	1	1	0	1	0
4	0	0	1	0	0	1	0	1
5	0	0	1	0	1	0	1	1
6	0	0	0	0	1	1	0	0
7	x	x	0	0	0	1	0	1
8	--	--	--	1	1	1	1	1

Dataword coding CR719L								
Addr	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
0	1	1	x	x	x	x	x	x
1	0	0	0	0	x	x	x	x
2	x	x	x	0	0	0	0	0
3	1	0	1	1	1	0	1	0
4	0	0	1	0	0	0	0	1
5	0	0	1	0	1	0	1	1
6	0	0	0	0	1	1	0	0
7	x	x	1	0	0	1	0	1
8	--	--	--	1	1	1	1	1

Dataword coding CR719M								
Addr	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
0	1	1	x	x	x	x	x	x
1	0	0	0	0	x	x	x	x
2	x	x	x	0	0	0	0	0
3	1	0	1	1	1	0	1	0
4	1	0	0	0	0	0	0	0
5	1	0	1	1	1	0	1	0
6	0	0	0	0	1	0	1	0
7	x	x	0	1	0	1	1	1
8	--	--	--	1	1	1	1	1

Dataword coding CR719P								
Addr	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
0	1	1	x	x	x	x	x	x
1	0	0	0	0	x	x	x	x
2	x	x	x	0	0	0	0	0
3	1	0	1	1	1	0	1	0
4	0	0	1	0	0	0	0	1
5	0	0	1	0	1	0	1	1
6	0	0	0	0	1	1	0	0
7	x	x	0	0	0	1	0	1
8	--	--	--	1	1	1	1	1

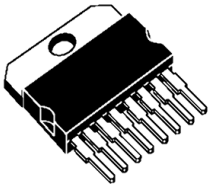
6. Package

6.1 MW8

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.0	4.5	5	0.157	0.177	0.197
B	2.45	2.55	2.65	0.096	0.10	0.104
C	1.43	1.515	1.6	0.056	0.06	0.063
E	0.49		0.55	0.019		0.022
F	0.78		0.85	0.030		0.033
F1	0.68		0.75	0.027		0.029
G	2.40	2.54	2.68	0.094	0.10	0.105
G1	17.64	17.78	17.92	0.69	0.70	0.71
H1	19.6	19.85	20.1	0.772	0.781	0.791
H2			20.2			0.795
L	20.35		20.65	0.80		0.81
L2	17.05	17.20	17.35	0.67	0.68	0.68
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L5	15.45		15.75	0.61		0.62
L5*	15.05		15.35	0.59		0.60
L7	2.65		2.9	0.104		0.114
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
U	0.40		0.55	0.015		0.022
Z	0.70		0.85	0.028		0.034
Dia1	3.65		3.85	0.144		0.152

L5 = with wedged frame std.
L5* = with wedged frame anchor holes.

OUTLINE AND MECHANICAL DATA



Multiwatt8 (Floating)

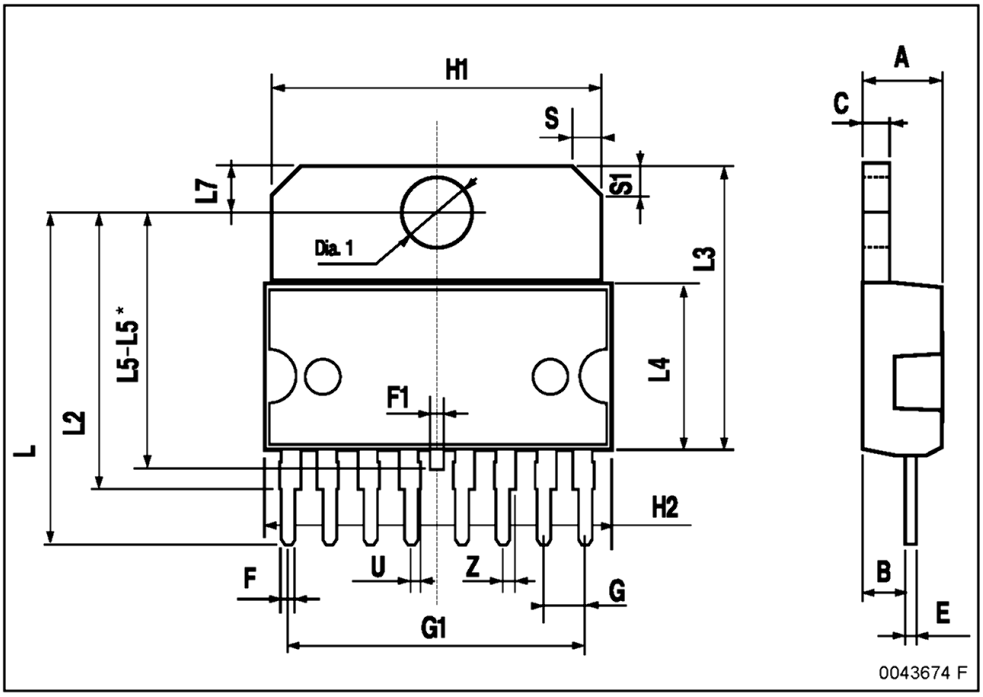


Figure 17 MW8 dimensions

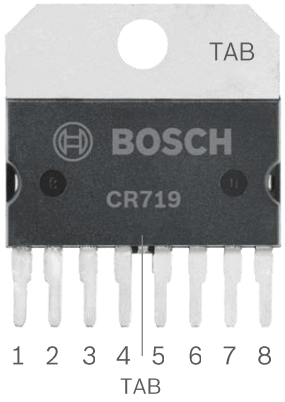


Figure 18 Package and pinout MW8

Pin		Function
1	DFM	Field monitor output
2	L	Lamp
3	n.c.	Not connected
4	B+	Battery
5	n.c.	Not connected
6	V	Phase signal input
7	DF	Field high side driver
8	GND	Ground
TAB	floating	

TAB can be floating or connected to ground.
TAB pin in between pin 4 and pin 5 is for mechanical robustness and is connected to the heatsink internally.

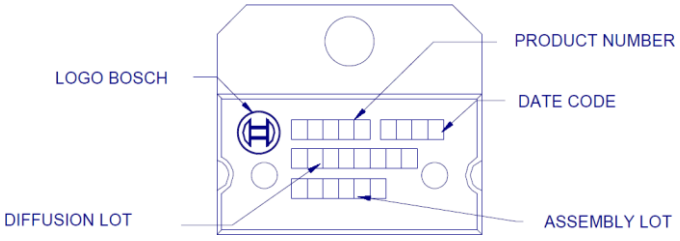
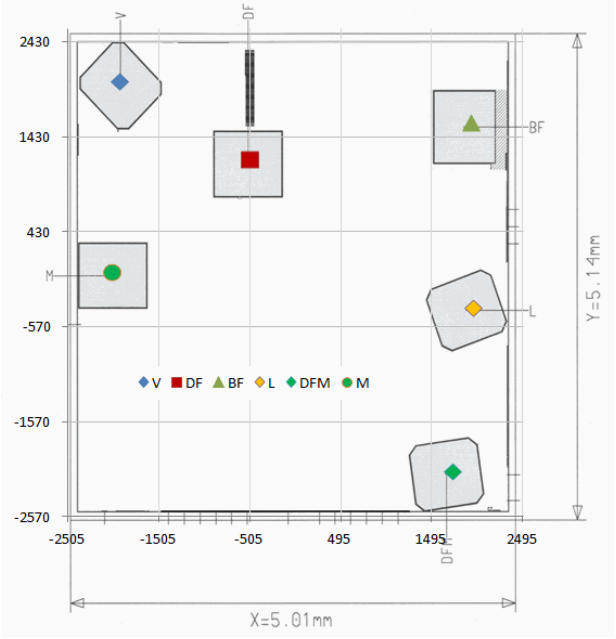


Figure 19 Marking

6.2 Bare die



Pad	mid x	mid y
V	–1935	2020.4
DF	–501	1193.5
B+	1932	1582.7
L	1954.2	–362.1
DFM	1728.8	–2090.9
GND	–2023	9.6

7. Document history

Issue	Date	Changes
1.00	2012-08-31	First edition
1.01	2014-03-07	V-Terminal description
1.02	2014-04-01	V-Terminal: Amplitude and frequency detection / update of wiring diagram
1.03	2014-06-10	MW8-Drawing: Implemented additional information
1.04	2014-10-06	L-Type removed, added K-Type
1.05	2014-10-15	Removed Draft / Preliminary marker, added document No.
1.06	2014-10-20	Editorial changes
1.07	2015-04-24	“Operating Current” Relay driver 0.5A removed (current limitation is 1.1A) “Operating Current” Lamp driver 5-330mA removed (current limitation is 500mA) Field driver self-protection updated (specified typical value, min-value=tbd) specified ESD-protection Specified Ureg over temperature (graphic) Vreg typical value corrected with value +50mV Editorial changes
1.08	2015-05-18	Specified IDF_Lim (min/typ)
2.00	2016-02-25	Extensive changes to document format (adapted to actual TCD format) Included several IC values in parameter tables Added details to acceleration mode and data word option Editorial changes

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