iC-GE100

PWM RELAY/SOLENOID DRIVER

preliminary

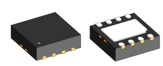
FEATURES

- ♦ Current control for inductive actuators at 24 V (10 to 36 V)
- ♦ Power saving and power dissipation reduced switching
- ♦ Individual setting of energising and hold current
- ♦ Contact conserving switching of relays synchronous to the mains
- ♦ High efficient current control up to 100 mA
- ♦ Monitoring of coil current, supply voltage and temperature
- ♦ Shutdown with overtemperature and undervoltage
- ♦ Status indication via LED or logic output
- ♦ Fast demagnetising with 15 V countervoltage

APPLICATIONS

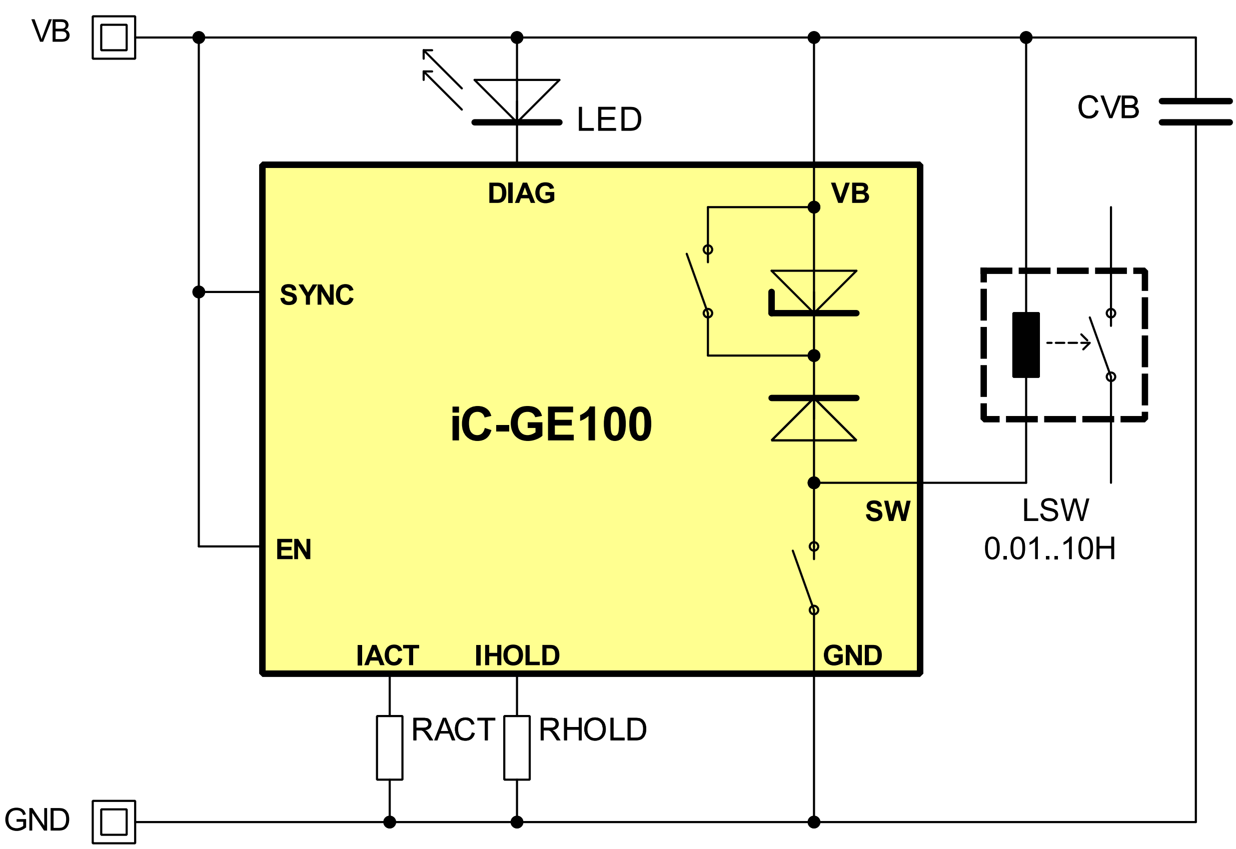
- ♦ PWM drive for inductive loads (e.g. 6/12 V relays, electrovalves) from 24 V
- ♦ Relay low-/high-side switch

PACKAGES



DFN8-3x3

BLOCK DIAGRAM



DESCRIPTION

iC-GE100 is a PWM driver for inductive loads, such as relay coils, solenoid valves and other inductive loads.

The setpoints for the coil's energising and hold current are pre-set by means of external resistors RACT and RHOLD. These currents can be set in a range from 10 to 100 mA. The iC-GE100 switches from energising to hold mode after 50 ms provided that the set energising current has been reached.

The changeover between energising and hold modes is suitable for typical relay drives which require a powerful initial energising current which can then be reduced after closing the air gap in a magnetic circuit. The quadratic dependence on the current intensity means that cutting the current by half reduces the power dissipation by ca. 75%.

Using PWM the output current is controlled to the values set at RACT and RHOLD. The internal flyback diode maintains the current during the switching pauses. The switching frequency of ca. 80 kHz is provided by the internal oscillator.

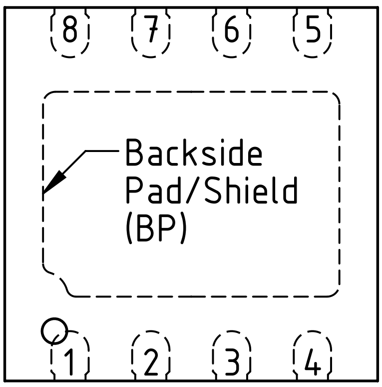
The device is shutdown by a Low signal at input EN or the removal of the power supply; the current reduction in the coil is supported by the changeover of the free-wheeling circuit. The Zener diode now active permits higher free-wheeling voltages and thus a quicker demagnetising of the coil.

The status indicator LED is constantly ON when hold mode is functioning correctly and flashes with low voltage, excessive temperature or when the coil current in energise mode has not reached the setpoint. The driver output is shutdown with low voltage or excessive temperature. Alternatively to using an LED output DIAG signals the correct operating by outputting a high signal.

The input signal at EN can be synchronised with the zero crossing at input SYNC. Thus by using an external R/C network, the switching of the coil can be synchronised with the load current of e.g. the relay.

PACKAGING INFORMATION DFN8-3x3

PIN CONFIGURATION DFN8 3 mm x 3 mm



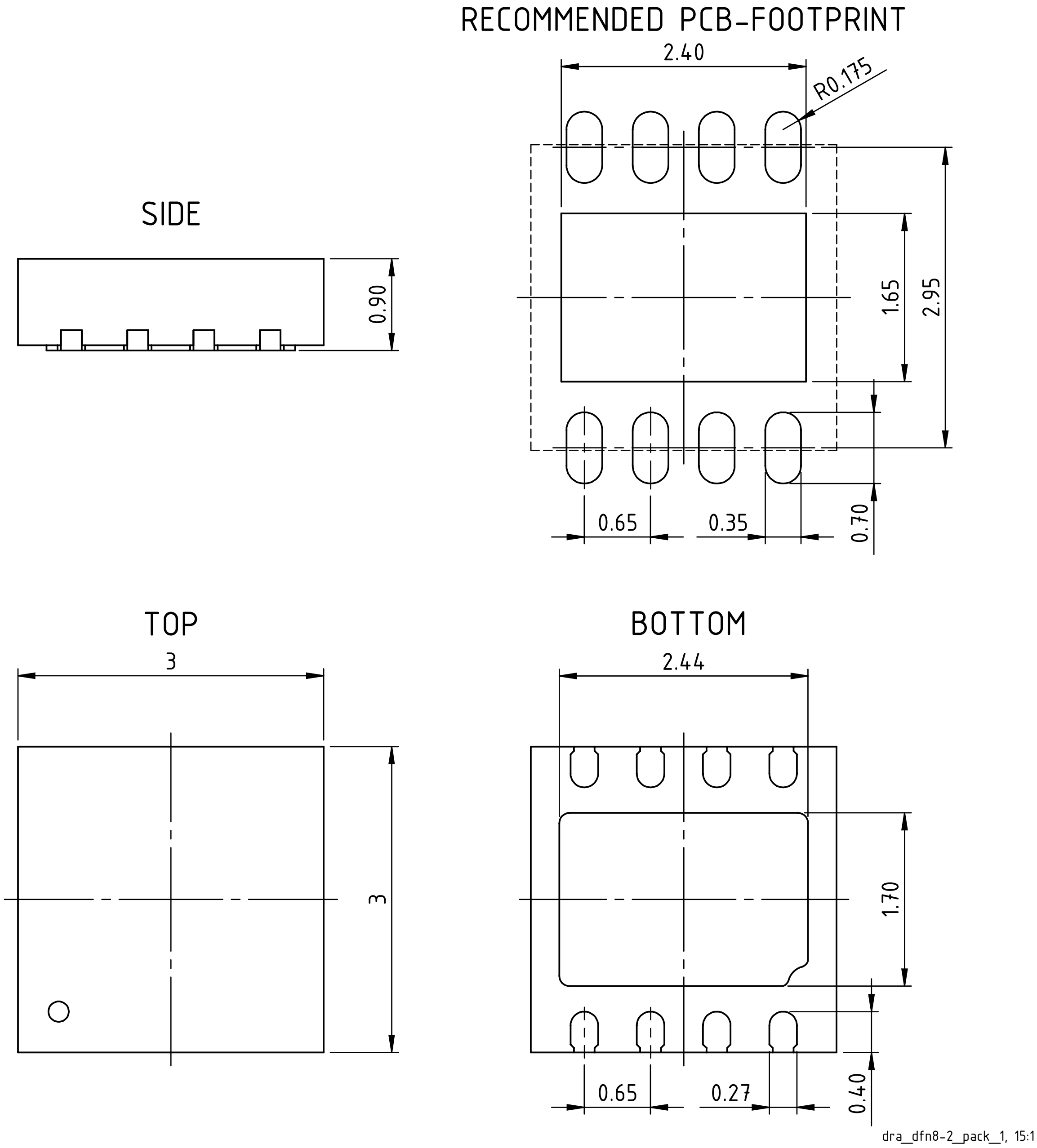
PIN FUNCTIONS

No.	Name	Function
1	GND	Ground
2	SW	PWM Output
3	VB	+10...36 V Supply Voltage
4	IHOLD	Hold Current Setup
5	IACT	Energising Current Setup
6	DIAG	Status Output
7	SYNC	Sync Input
8	EN	Enable Input

The *Thermal Pad* is to be connected to a Ground Plane (GND) on the PCB.
Only pin 1 marking on top or bottom defines the package orientation (iC GE100 label and coding is subject to change).

PACKAGE DIMENSIONS DFN8-3x3

All dimensions given in mm.



ABSOLUTE MAXIMUM RATINGS

Beyond these values damage may occur; device operation is not guaranteed.

Item No.	Symbol	Parameter	Conditions	Min.	Max.	Unit
G001	V(VB)	Voltage at VB		-0.3	37	V
G002	I(VB)	Current in VB		-100	6	mA
G003	V(SW)	Voltage at OUT		-0.3	53	V
G004	I(SW)	Output Current in OUT		-6	100	mA
G005	V(DIAG)	Voltage at LED		-0.3	37	V
G006	I(DIAG)	Current in LED		-6	8	mA
G007	V(IACT)	Voltage at ISET		-0.3	7	V
G008	I(IACT)	Current in ISET		-6	6	mA
G009	V(IHOLD)	Voltage at IHOLD		-0.3	7	V
G010	I(IHOLD)	Current in IHOLd		-6	6	mA
G011	V(EN)	Voltage at IN		-0.3	37	V
G012	I(EN)	Current in IN		-6	6	mA
G013	V(SYNC)	Voltage at SYNC		-6	37	V
G014	I(SYNC)	Current in SYNC		-6	6	mA
G015	VD()	Susceptibility to ESD at all pins	HBM 100 pf discharged through 1.5 kΩ		2	kV
G016	Tj	Junction Temperature		-40	150	°C
G017	Ts	Storage Temperature		-40	150	°C

THERMAL DATA

Operating Conditions: VB = 10...36 V, LSW = 0.01...10 H, RACT = 6.2 k...62 kΩ, RHOLD = 6.2 k...62 kΩ

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
T01	Ta	Operating Ambient Temperature Range		-40		85	°C
T02	Rthja	Thermal Resistance Chip/Ambient	surface mounted, thermal pad soldered to ca. 2 cm^2 heat sink		30	40	K/W

All voltages are referenced to ground unless otherwise stated.
All currents flowing into the device pins are positive; all currents flowing out of the device pins are negative.

ELECTRICAL CHARACTERISTICS

Operating Conditions: VB = 10...36 V, LSW = 0.01...10 H, RACT = 6.2 k...62 kΩ, RHOLD = 6.2 k...62 kΩ, Tj = -40...125 °C.

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Total Device							
001	VB	Permissible Supply Voltage Range		10		36	V
002	I(VB)	Supply Current in VB	EN < 0.8 V			20	µA
003	I(VB)	Supply Current in VB	EN = hi	0.5		4	mA
004	Vc()lo	Clamp Voltage lo at all Pins	I() = -4 mA, other Pins open	-1.4		-0.3	V
005	Vc()lo	Clamp Voltage lo SYNC	I() = -4 mA, other pins open			-7	V
006	Vc()hi	Clamp Voltage hi at VB, EN, DIAG, SYNC	I() = 4 mA, other Pins open	37			V
007	Vc()hi	ClampVoltage hi at IACT, IHOLD	I() = 4 mA, other pins open	7			V
008	Vc()hi	Clamp Voltage hi at SW	I(SW) = 4 mA, referenced to VB, other pins open	10		17	V
Driver Output SW							
101	Vs()lo	Saturation Voltage lo	I(SW) = 100 mA (cf. Fig. 1)			700	mV
102	Vs()lo	Saturation Voltage lo	I(SW) = 10 mA (cf. Fig. 1)			100	mV
103	I(SW)	PWM-Current Range		10		100	mA
104	Isc()	Short-circuit Current	V(SW) = VB	100		tbd	mA
105	Vc()hi	Clamp Voltage hi at PWM-Free-Wheeling	Vc()hi = V(SW) − VB; EN = hi, I(SW) = 100 mA (cf. Fig. 1)			600	mV
106	Vc()hi	Clamp Voltage hi at PWM-Free-Wheeling	Vc()hi = V(SW) − VB; EN = hi, I(SW) = 10 mA (cf. Fig. 1)			100	mV
107	Vc()off	Clamp Voltage hi at Turn-off	Vc()hi = V(SW) − VB; EN: hi → lo, I(SW) = 100 mA (cf. Fig. 1)	12	15	17	V
108	IlK()	Leakage Current	IN = lo, V(SW) = 0...VB		1	10	µA
109	twon()min	Minimum PWM Turn-on Duration	EN = hi, I(SW) > I(SW)act resp. I(SW)hold (cf. Figure 1)	250		1000	ns
Input IN							
201	Vt()on	Threshold Voltage hi		1.0		1.4	V
202	Vt()off	Threshold Voltage lo		0.8		1.1	V
203	Vt()hys	Hysteresis	Vt()hys = Vt()on − Vt()off	200		450	mV
204	Ipd()	Pull-down Current	V(EN) = 0.8...36 V			40	µA
205	tp(VB-SW)	Turn-on Delay after power-up	EN = VB, VB = VBoff → VBon			40	µs
206	tp(EN-SW)	Turn-on Delay	EN: lo → hi until SW active	30			µs
207	tp(EN-SW)	Turn-off Delay	EN: hi → lo until SW inactive	10			µs
208	tp(EN-DIAG)	Delay Time from EN to DIAG = hi or LED permanently on	no error	20			µs
Status Monitor DIAG							
401	Ipd()	Pull-down Current	V(DIAG) = 6 V...VB, SW active, no error	3	5	8	mA
402	VBlo	Permissible Supply Voltage for LED operation at DIAG		6		36	V
403	V()hi	Hi-Level at DIAG	without LED	3.4		5.0	V
404	f()	Frequency on Error		1.8	2.4	3.6	Hz
405	Vs()lo	Saturation Voltage lo	I(DIAG) = 200 µA, without LED			0.4	V
406	Ipu()	Pull-up Current	V(DIAG) = 0 ...4 V	-120	-100	-70	µA
407	VBon	Turn-on Threshold at VB	V(DIAG): lo → hi	8	8.5	9	V
408	VBoff	Undervoltage Threshold at VB	Decreasing voltage VB, V(DIAG): hi → lo	7.5	8	8.5	V
409	VBhys	Hysteresis	VBhys = VBon − VBoff	200	500	800	mV
410	Toff	Thermal Shutdown Temperature		140		170	°C
411	Ton	Thermal Release Temperature	Decreasing temperature	120		150	°C
412	Thys	Thermal Shutdown Hysteresis	Thys = Toff − Ton	10	20	30	°C

ELECTRICAL CHARACTERISTICS

Operating Conditions: VB = 10...36 V, LSW = 0.01...10 H, RACT = 6.2 k...62 kΩ, RHOLD = 6.2 k...62 kΩ, Tj = -40...125 °C.

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Reference IACT and IHOLD							
701	V()	Reference Voltage IACT and IHOLD		1.21	1.27	1.33	V
702	Isc()	Short-Circuit Current	V(IHOLD) = 0 V or V(IACT) = 0 V	-3.5	-1.8	-0.3	mA
703	K1	Transfer Value for Energising Current RACT = K1 / I(SW)act	I(SW)act = 10...100 mA	560	620	740	AΩ
704	K2	Transfer Value for Hold Current RHOLD = K2 / I(SW)hold	I(SW)hold = 10...100 mA	560	620	740	AΩ
Oscillator							
J01	fosc	Mean Oscillator Frequency	(fmax + fmin) / 2	60	80	120	kHz
J02	df	Frequency Variation	(fmax − fmin) / (2 ∗ fosc)	12		15	%
Synchronisation SYNC							
S01	Vth()sync	Trigger Threshold at SYNC		-40		40	mV
S02	Ilk()	Leakage Current	V(SYNC) = -3 V ... 3 V	-100		100	nA

ELECTRICAL CHARACTERISTICS: Diagrams

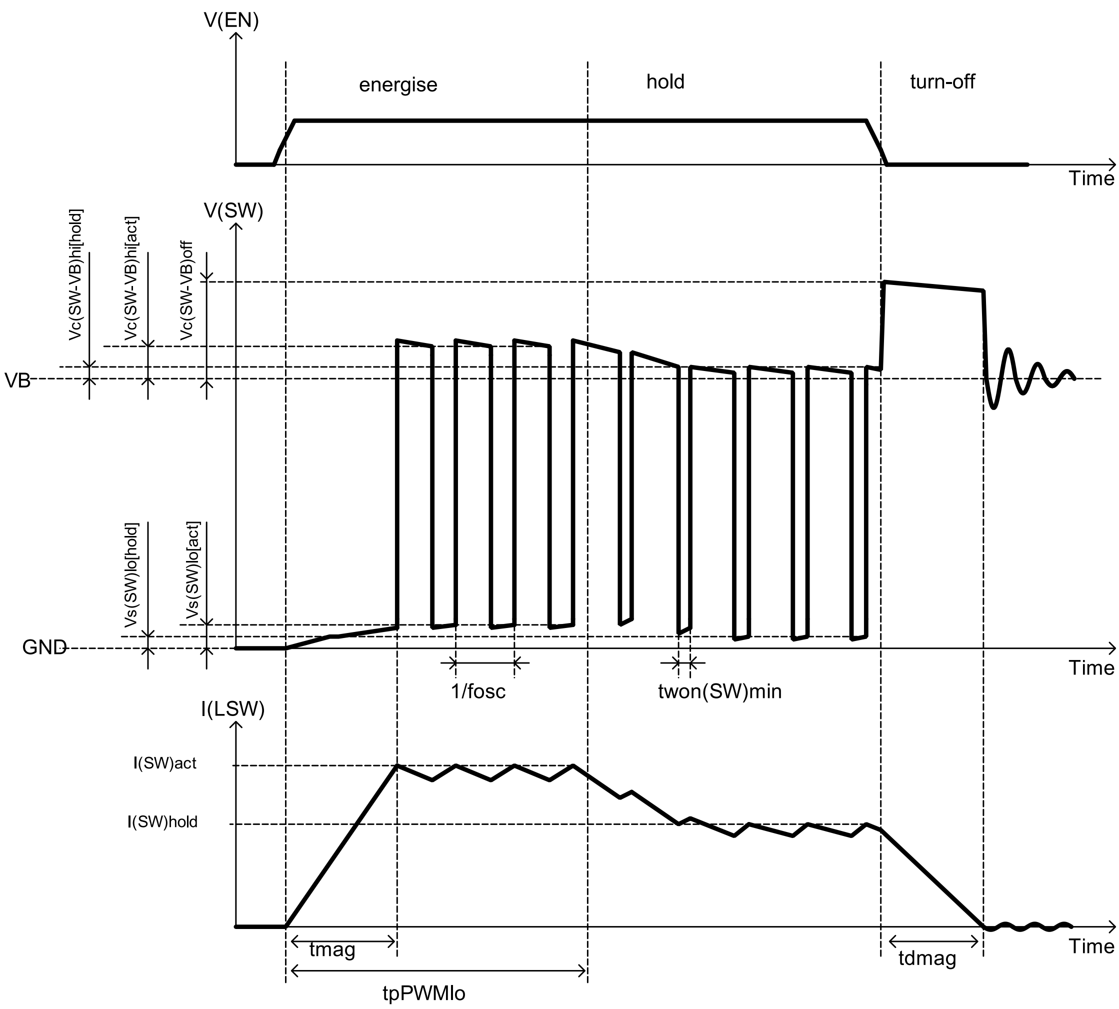


Figure 1: Operation modes: energise mode, hold mode and turn-off

$$t_{mag} \approx \frac{I(SW)_{act} \times LSW}{VB} \quad (1)$$

$$t_{dmag} \approx \frac{I(SW)_{hold} \times LSW}{V_c(SW - VB)_{off}} \quad (2)$$

APPLICATIONS INFORMATION

Setting the coil current

The following equations can be given for the energise and hold modes of the PWM control using Electrical Characteristics Nos. 703 resp. 704:

$$RACT = \frac{K1}{I(SW)_{act}} \tag{3}$$

$$RHOLD = \frac{K2}{I(SW)_{hold}} \tag{4}$$

Example

For a relay with a starting current of 70 mA and 40 mA hold current the following applies:

$$RACT = \frac{620\Omega A}{0.07\,A} = 8.8\,k\Omega \tag{5}$$

$$RHOLD = \frac{620\Omega A}{0.04\,A} = 15.5\,k\Omega \tag{6}$$

Application circuits

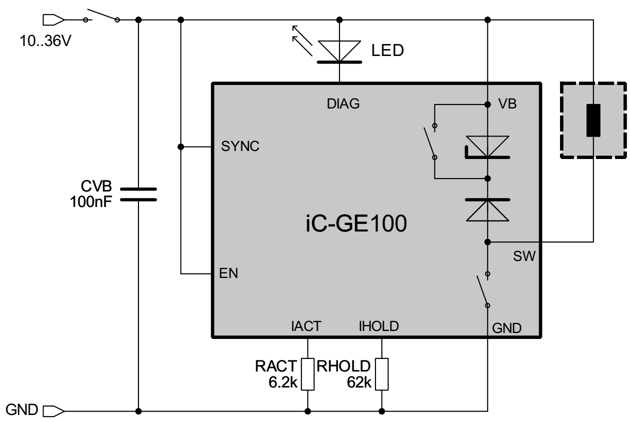


Figure 2: Activation by switching VB

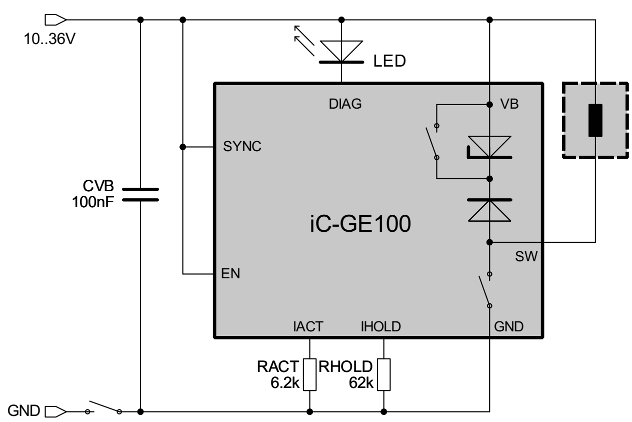


Figure 3: Activation by switching GND

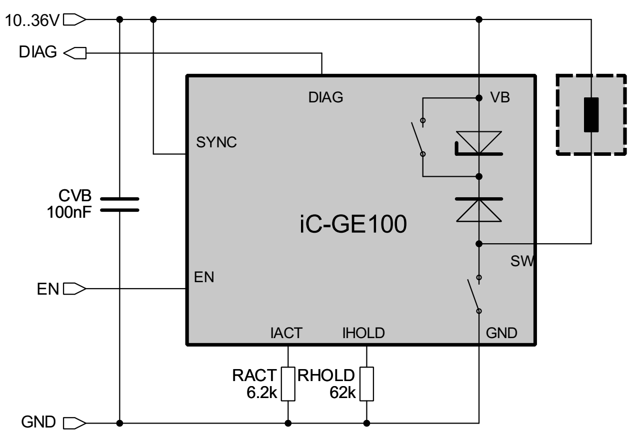


Figure 4: Activation via EN
feedback from DIAG with 5 V logic levels

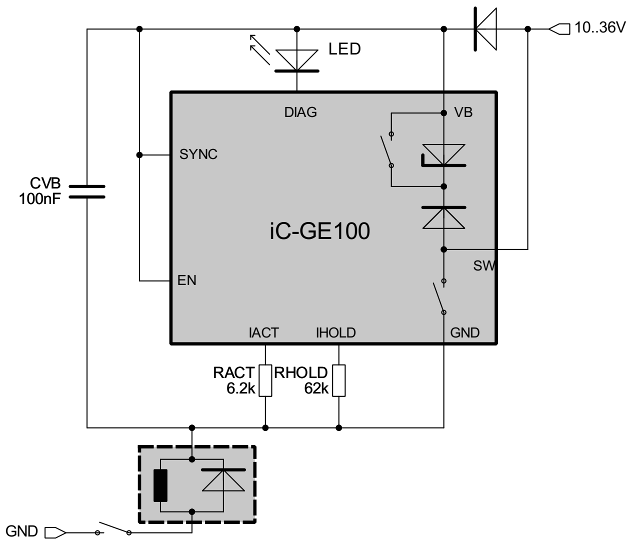


Figure 5: High-side driver for relays with free-wheeling diode

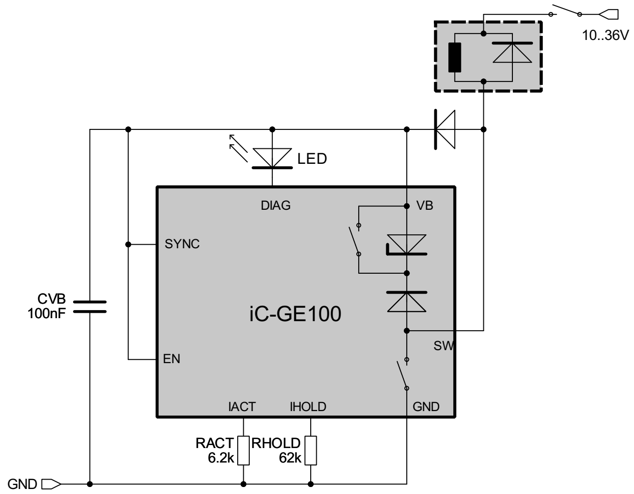


Figure 6: Low-side driver for relays with free-wheeling diode

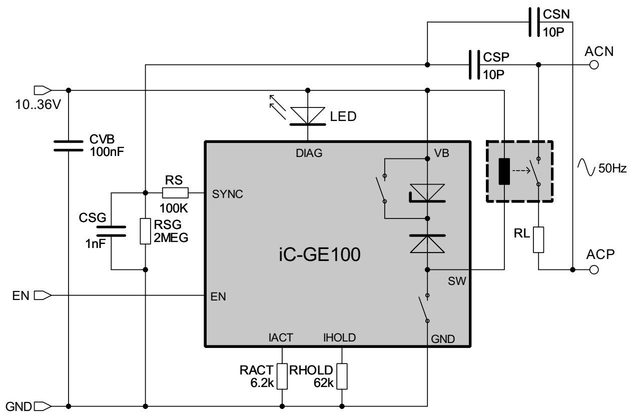


Figure 7: Utilising the SYNC input

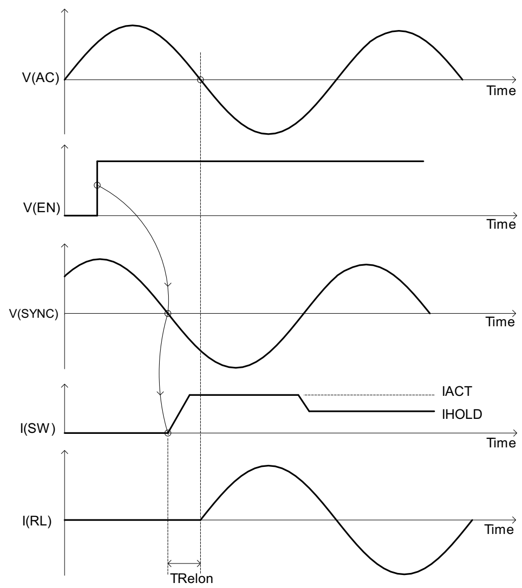


Figure 8: Utilising the SYNC input

By means of resistors RS* and capacitors CS* a phase shifted signal at SYNC is derived from the 50 Hz load supply.

Thus the relay is activated resp. deactivated with zero crossing of the load supply after working EN.

The phase shift is used to compensate the switching delay of the relay so that the load can be switched at zero current.

The benefit from synchronous switching may be utilised, if the switching times are short and reproducible.

EVALUATION BOARD

iC-GE100 comes with an evaluation board for test purpose. Figures 9 and 10 show both the schematic and the component side of the evaluation board.

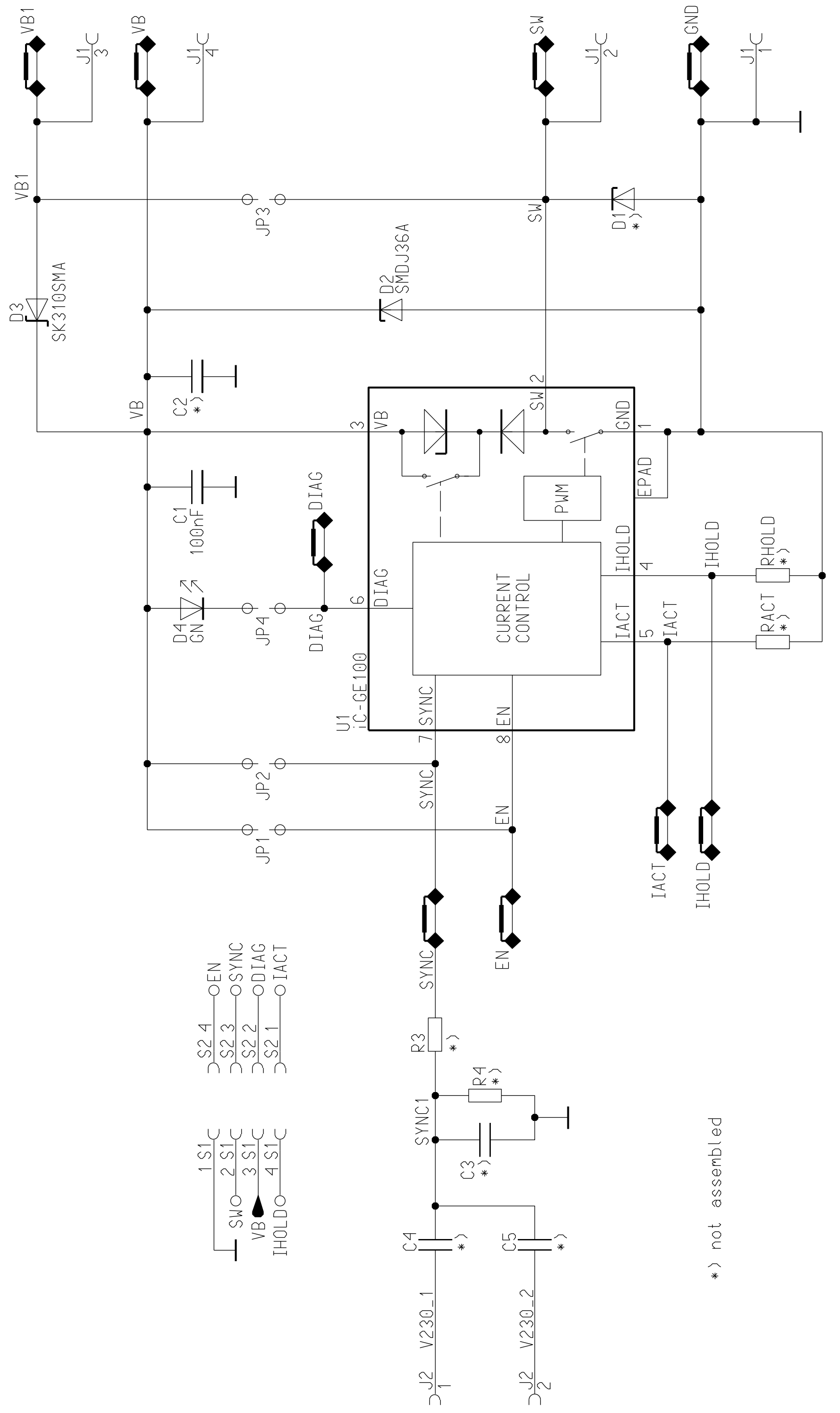


Figure 9: Schematic of the evaluation board

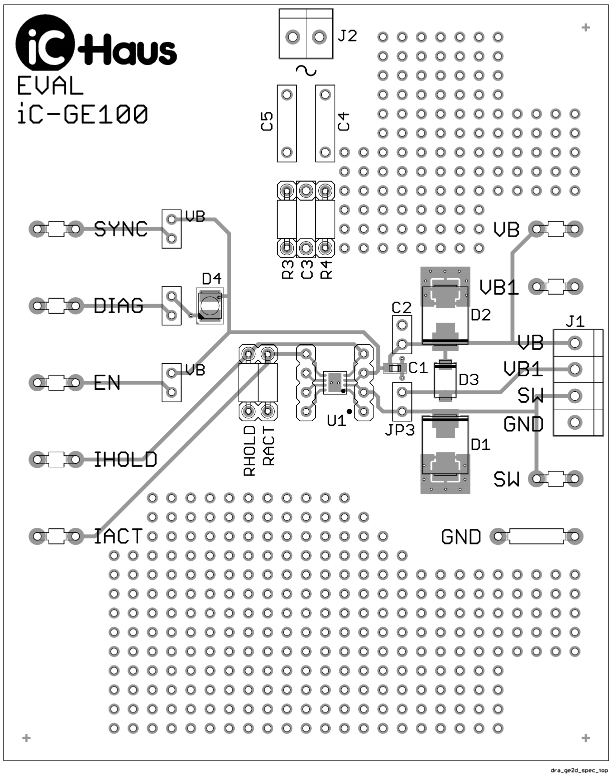


Figure 10: Evaluation board (component side)

REVISION HISTORY

Rel.	Rel. Date*	Chapter	Modification	Page
B1	2015-12-03	ELECTRICAL CHARACTERISTICS	007 deleted; double entry 101, 201, 203, 204, 406, 701, 702, 703, 704, S01, S02 synchronised with ATE	5, 6

* Release Date format: *YYYY-MM-DD*

ORDERING INFORMATION

Type	Package	Order Designation
iC-GE100	DFN8 3 mm x 3 mm Evaluation Board	iC-GE100 DFN8-3x3 iC-GE100 EVAL GE2D

Please send your purchase orders to our order handling team:

Fax: +49 (0) 61 35 - 92 92 - 692
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