iC-JE

PWM RELAY/SOLENOID DRIVER

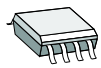
FEATURES

- Wide operating voltage range of 10 to 45 Vdc
- PWM control for coil currents of 40 to 300 mA
- Coil current for energise and hold modes set by an external resistor
- Coil current monitored during energise mode, detection of load breakage and voltage errors
- Automatic current reduction after 100 ms to reduce the power consumption in hold mode
- The internal free-wheeling alteration function supports PWM operation and quick demagnetising during shutdown
- Status signalled at the current-limited LED output
- Shutdown with excessive temperature and low voltage
- Integrated oscillator needs no external components
- PWM frequency is beyond audible range
- Protective circuitry against damage by ESD
- Minimum space requirements, few external components

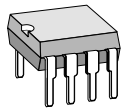
APPLICATIONS

- PWM drive for inductive loads (e.g. relays, electrovalves)
- Relay low-/high-side switch

PACKAGES

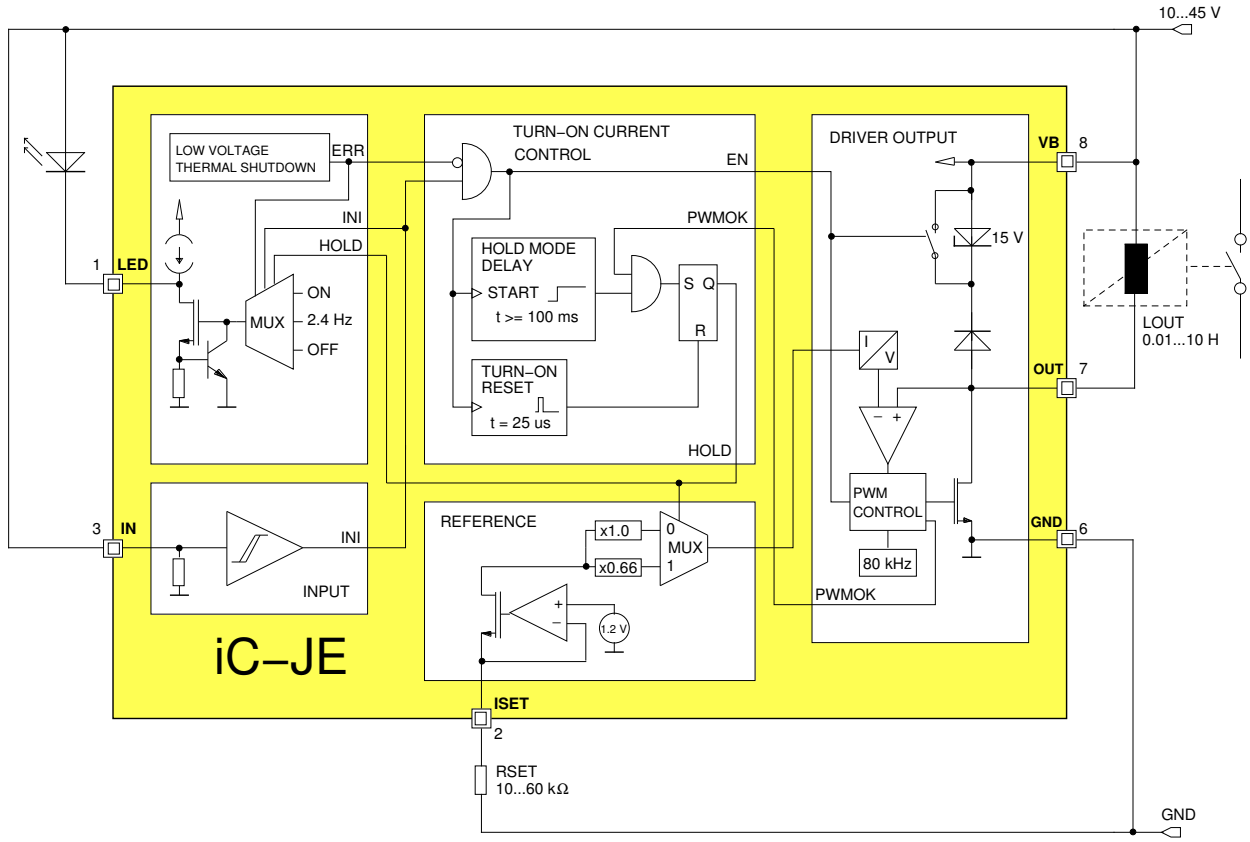


SO8



PDIP8

BLOCK DIAGRAM



DESCRIPTION

iC-JE is a PWM driver for inductive loads, such as relay coils, solenoid valves and small DC motors.

The setpoint for the coil current is preset with the help of the RSET external resistor. 60 to 300 mA can be set for energise mode which then automatically drop to 2/3 of this value (40 to 200 mA) during hold mode. The device is switched to hold mode after 100 ms provided that the set coil current is obtained during energising (PWMOK = 1).

The changeover between energise 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 the power dissipation of the system is more than halved through this reduction.

The output current is measured with zero loss at the power transistor's ON resistance and compared to the setpoint. In order to maintain this setpoint, the switch-on time of the coil driver is modulated by the pulse width. The internal flyback diode maintains the current during the switching pauses. The switching frequency of ca. 80 kHz is provided by the internal oscillator.

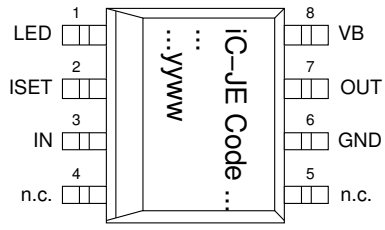
The device is shutdown by a Low signal at input IN or the removal of the power supply; the current reduction in the coil is supported by the changeover of the free-wheeling circuit. The Zener diode now active permits higher free-wheeling voltages and thus a quicker demagnetising of the coil.

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.

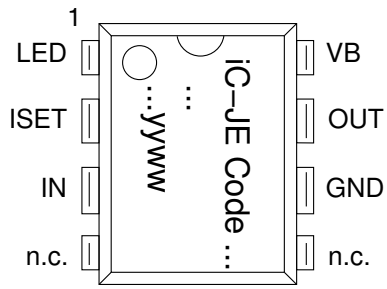
The device is protected against destruction by ESD.

PACKAGES SO8, PDIP8 to JEDEC

PIN CONFIGURATION SO8
(top view)



PIN CONFIGURATION PDIP8
(top view)



PIN FUNCTIONS

No.	Name	Function
1	LED	State monitor
2	ISET	PWM Reference Current (setpoint adjustment)
3	IN	Input
4	n.c.	
5	n.c.	
6	GND	Ground
7	OUT	PWM Output
8	VB	+10 to 45 V Supply Voltage

ABSOLUTE MAXIMUM RATINGS

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

Item No.	Symbol	Parameter	Conditions	Fig.	Min.	Max.	Unit
G001	V(VB)	Voltage at VB			-0.3	48	V
G002	I(VB)	Current in VB			-350	6	mA
G003	V(OUT)	Voltage at OUT			-0.3	60	V
G004	I(OUT)	Output Current in OUT			-6	350	mA
G005	V(LED)	Voltage at LED			-0.3	VB	V
G006	I(LED)	Current in LED			-6	8	mA
G007	V(ISET)	Voltage at ISET			-0.3	48	V
G008	I(ISET)	Current in ISET			-6	6	mA
G009	V(IN)	Voltage at IN			-0.3	48	V
G010	I(IN)	Current in IN			-6	6	mA
G011	Tj	Junction Temperature			-40	150	°C
G012	Ts	Storage Temperature			-40	150	°C

THERMAL DATA

Operating Conditions: VB = 10...45 V, LOUT = 0.01...10 H, RSET = 10...60 kΩ

Item No.	Symbol	Parameter	Conditions	Fig.	Min.	Typ.	Max.	Unit
T01	Ta	Operating Ambient Temperature Range			-25		80	°C
T02	Rthja	Thermal Resistance Chip/Ambient	PDIP8 package				110	K/W
T03	Rthja	Thermal Resistance Chip/Ambient	SO8 package				140	K/W

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

ELECTRICAL CHARACTERISTICS

Operating Conditions: VB = 10...45 V, LOUT = 0.01...10 H, RSET = 10...60 kΩ, Tj = -25...125 °C, unless otherwise noted.
LED connected or pin LED linked to GND (via ca. 500 Ω resistor or capacitor).

Item No.	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
Total Device									
001	VB	Permissible Supply Voltage Range				10		45	V
002	I(VB)	Supply Current in VB	Outputs OUT, LED disabled			0.5		2	mA
003	I(VB)	Supply Current in VB	Output OUT enabled			0.5		3	mA
004	Vc()lo	Clamp Voltage lo at all Pins	I() = -4 mA, other Pins open			-1.4		-0.3	V
005	Vc()hi	Clamp Voltage hi at VB, IN, ISET	I() = 4 mA, other Pins open			48	57		V
006	Vc()hi	Clamp Voltage hi at OUT	I(OUT) = 4 mA, other Pins open			60	71		V
007	Vc()hi	Clamp Voltage hi at LED vs. VB	Vc()hi = V(LED) − V(VB); I(LED) = 4 mA, other Pins open			0.3		1.4	V
Driver Output OUT									
101	Vs()lo	Saturation Voltage lo	I(OUT) = 200 mA		1		360	600	mV
102	Vs()lo	Saturation Voltage lo	I(OUT) = 300 mA		1		550	850	mV
103	PWMthi	Permissible Energising Current	Increased Energising Current by RC-circuit at ISET, Hold Current 200 mA max.		1 5, 6			300 350	mA mA
104	PWMthi	Permissible Hold Current			1	40			mA
105	Isc()	Short-circuit Current	V(OUT) = VB			0.6	1	1.7	A
106	Vc()hi	Clamp Voltage hi at PWM-Free-Wheeling	Vc()hi = V(OUT) − VB; IN = hi, I(OUT) = 200 mA		1		1	1.5	V
107	Vc()hi	Clamp Voltage hi at PWM-Free-Wheeling	Vc()hi = V(OUT) − VB; IN = hi, I(OUT) = 300 mA		1		1.4	2	V
108	Vc()off	Clamp Voltage hi at Turn-off	Vc()hi = V(OUT) − VB; IN: hi → lo, I(OUT) = 200 mA		1	12	15	17	V
109	IIK()	Leakage Current	IN = lo, V(OUT) = 0...VB				1	10	µA
110	twon()min	Minimum PWM Turn-on Duration	IN = hi, ISET open		1	250		1000	ns
111	C()	Permissible Load Capacitance						1	nF
Input IN									
201	Vt()on	Threshold Voltage hi				2.6	2.85	3.2	V
202	Vt()off	Threshold Voltage lo				1.7	2.0	2.3	V
203	Vt()hys	Hysteresis	Vt()hys = Vt()on − Vt()off			0.7	0.85	1.1	V
204	Ipd()	Pull-down Current	V(IN) = 4...45 V			50	100	200	µA
205	Rpd()	Pull-down Resistor	V(IN) = 0...4 V			20	50	80	kΩ
206	tp(IN-OUT)	Turn-on Delay	IN: lo → hi					20	µs
207	tp(IN-OUT)	Turn-off Delay	IN: hi → lo					10	µs
208	tp(VB-OUT)	Turn-on Delay when VB is powered up	IN = VB, VB = VBoff → VBon					40	µs
209	tp(IN-LED)	Delay Time from IN to LED (with light permanently on)	PWMOK = 1 before tpPMWlo			65	100	135	ms
210	tp(IN-LED)	Delay Time from IN to LED (with light flashing)	PWMOK = 0			130	200	270	ms
Status Monitor LED									
301	Ipd()	Pull-down Current	V(LED) = 5 V...VB			3	5	8	mA
302	Vs()lo	Saturation Voltage lo	I(LED) = 200 µA					0.4	V
303	Ipu()	Pull-up Current	V(LED) = 0 V...(VB − 1 V)			-20	-100	-300	µA
304	VBlo	Permissible Supply Voltage for Monitoring Function				6		45	V
305	VBon	Turn-on Threshold at VB				7.6	8	8.4	V
306	VBoff	Undervoltage Threshold at VB	Decreasing voltage VB			7.1	7.5	7.9	V
307	VBhys	Hysteresis	VBhys = VBon − VBoff			200	500	800	mV
308	Toff	Thermal Shutdown Temperature				130	140	150	°C

ELECTRICAL CHARACTERISTICS

Operating Conditions: VB = 10...45 V, LOUT = 0.01...10 H, RSET = 10...60 kΩ, Tj = -25...125 °C, unless otherwise noted.
LED connected or pin LED linked to GND (via ca. 500 Ω resistor or capacitor).

Item No.	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
309	Ton	Thermal Lock-on Threshold	Decreasing temperature			110	120	130	°C
310	Thys	Thermal Shutdown Hysteresis	Thys = Toff − Ton			10	20	30	°C
311	f()	Flash Frequency on Error	ERR = hi or PWMOK = 0, VB = 6...45 V			1.8	2.4	3.6	Hz
Reference ISET									
401	V()	Reference Voltage				1.14	1.20	1.26	V
402	Isc()	Short-Circuit Current	V(ISET) = 0 V			-2.5	-1.8	-0.3	mA
403	K1	Transfer Value for Energising Current RSET = K1 / I(OUT)start	I(OUT)start = 60...300 mA		1	2900	3400	3900	AΩ
404	CRrel	Relative Current Ratio It(OUT)hold / It(OUT)start (Trigger Thresholds Ratio: Hold vs. Energise Mode)	I(OUT)start = 60...300 mA		1	63	66	71	%
405	K2	Transfer Value for Hold Current RSET = K2 / I(OUT)hold	I(OUT)hold = 40...200 mA			1930	2315	2700	AΩ
Oscillator									
501	fosc	Oscillator Frequency			1	60	80	120	kHz
Turn-on Current Control									
601	tpPWMlo	Hold Mode Propagation Delay	PWMOK = 1 before tpPWMlo			65	100	135	ms

ELECTRICAL CHARACTERISTICS: Diagrams

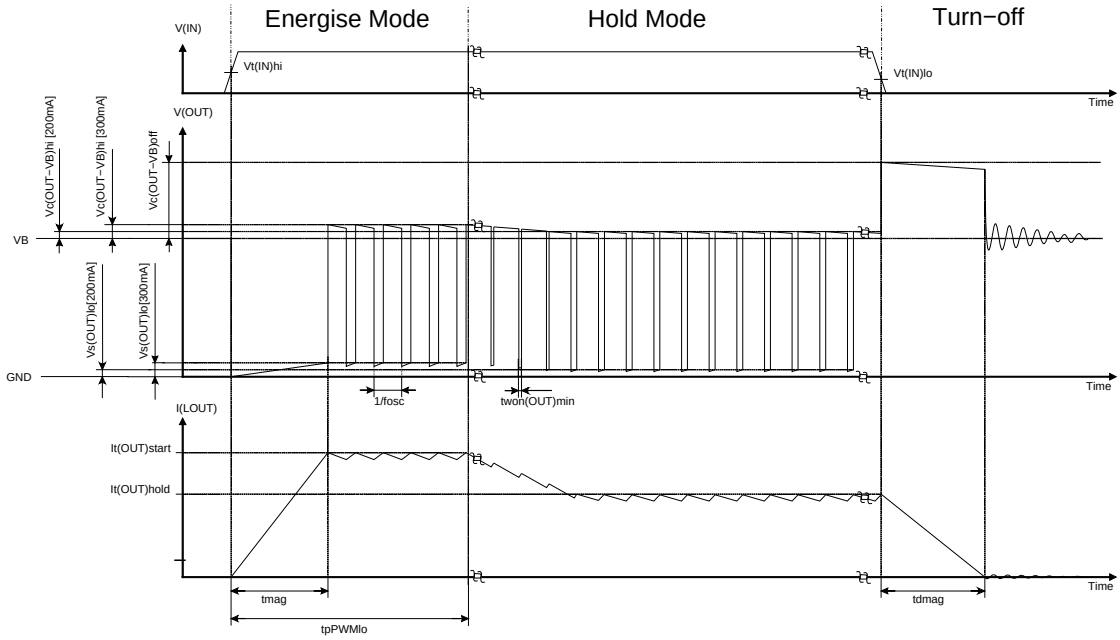


Figure 1: Operation modes: energise mode, hold mode and turn-off

$$t_{mag} \approx \frac{It(OUT)_{start} \times LOUT}{VB} \quad (1)$$

$$t_{dmag} \approx \frac{It(OUT)_{hold} \times LOUT}{V_c(OUT - VB)_{hi}} \quad (2)$$

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. 403 to 408:

$$RSET = \frac{K2}{I(OUT)_{hold}} \quad (4)$$

Example

For a relay with a starting current of 100 mA (66 mA hold current) RSET is calculated as:

$$RSET = \frac{K1}{I(OUT)_{start}} \quad (3)$$

$$RSET = \frac{3250\,\Omega A}{0.1 A} = 32.5\,k\Omega \quad (5)$$

Application circuits

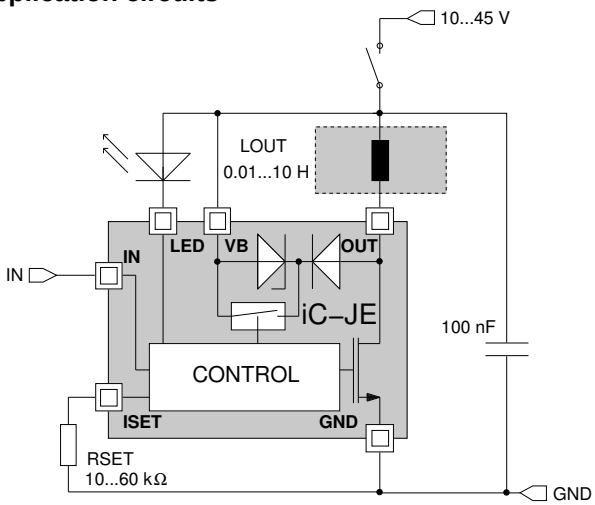


Figure 2: Driver/relay combination activated via the external control input IN

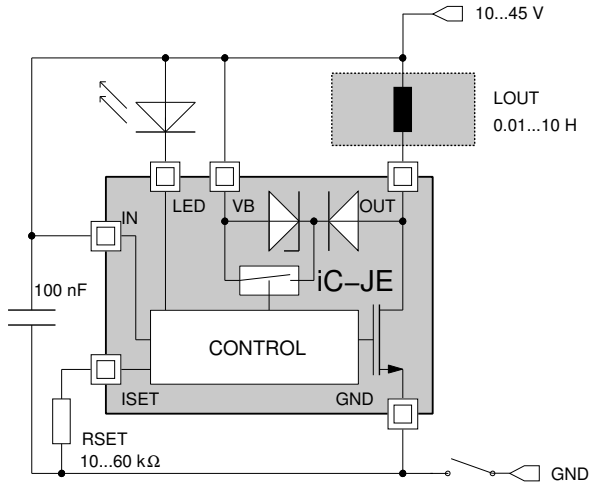


Figure 3: Driver/relay combination activated via the supply pin GND

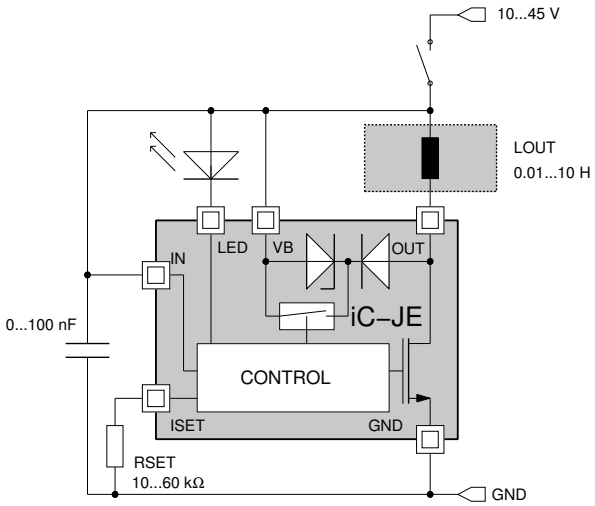


Figure 4: Driver/relay combination activated via the supply pin VB

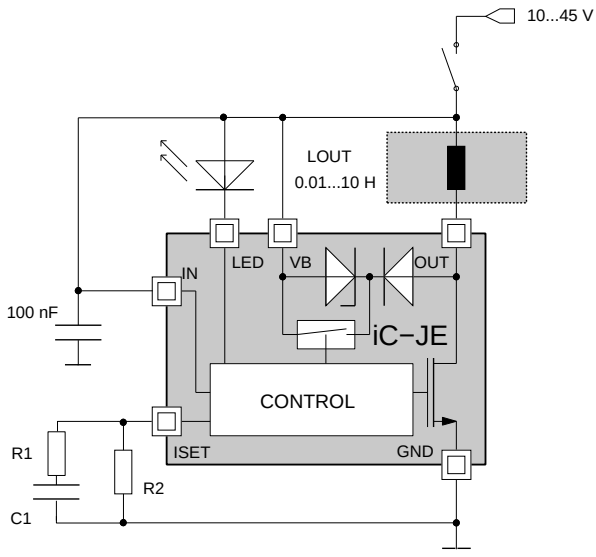


Figure 5: Increased energizing current due to the parallel RC-circuit

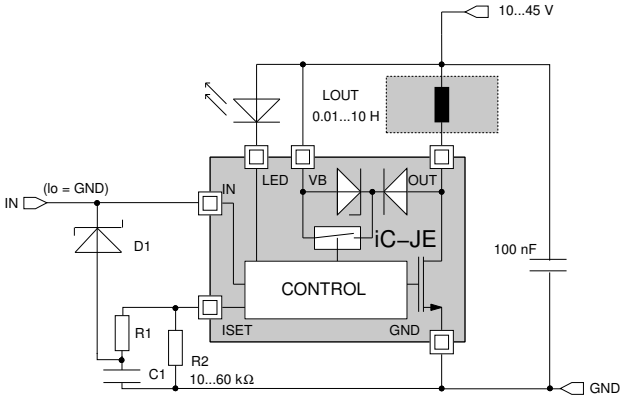


Figure 6: Activation via pin IN with an increased energizing current. An additional Schottky diode discharges C1 if IN is switched to low (GND)

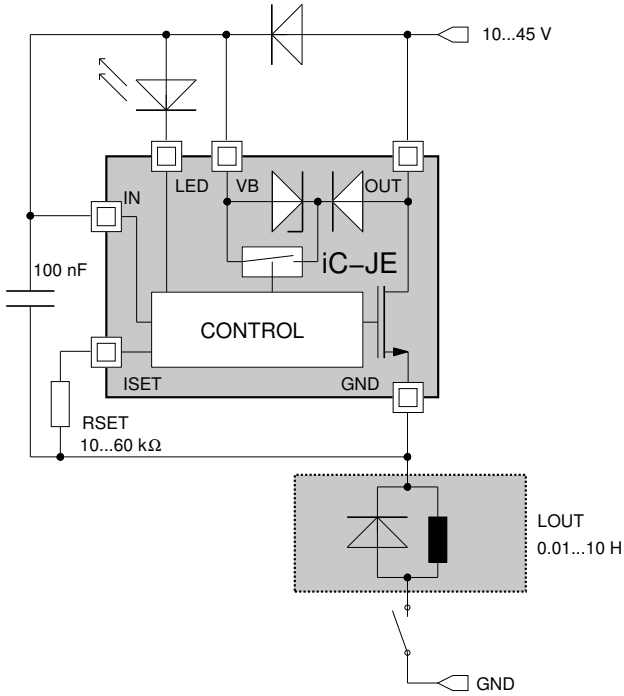


Figure 7: High-side driver for an external relay with a flyback diode

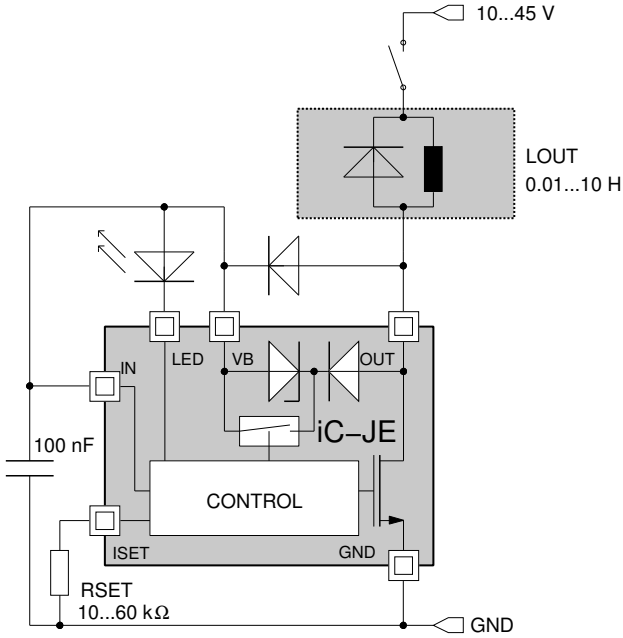


Figure 8: Low-side driver for an external relay with a flyback diode

EVALUATION BOARD

The iC-JE is equipped with a Evaluation Board for test purposes. The following figures show the circuit diagram as well as the top and bottom layout of the test PCB.

The board comes with a strap between IN and SENSE1 (application equal to Fig. 4). The actual coil current can be measured by the voltage drop between SENSE1 and SENSE2 (1 mV/mA).

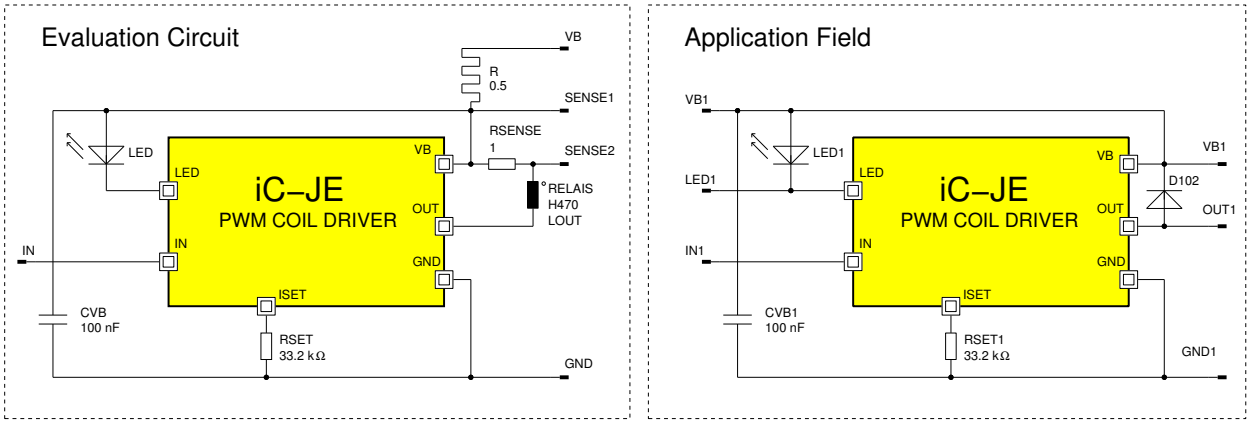


Figure 9: Schematic diagram of the Evaluation Board

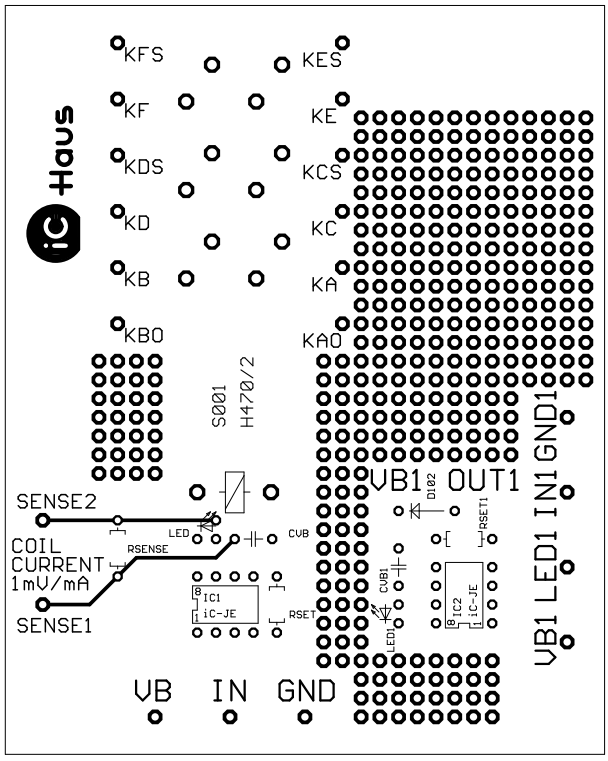


Figure 10: Evaluation Board (components side)

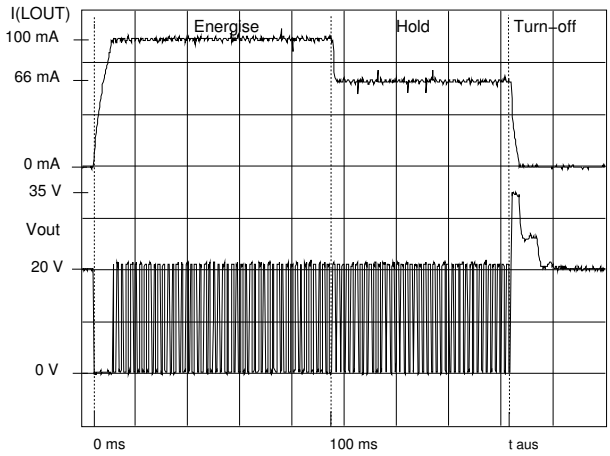


Figure 11: Oscilloscope graph of the evaluation circuit (sampled)

ORDERING INFORMATION

Type	Package	Order Designation
iC-JE	PDIP8 SO8	iC-JE PDIP8 iC-JE SO8
Evaluation Board		iC-JE EVAL JE1D

For information about prices, terms of delivery, other packaging options etc. please contact:

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