iC-MJ
LOW-POWER HALL SENSOR

preliminary

iC-Haus

FEATURES

♦ Hall sensor for absolute evaluation of magnetic field strength
♦ Pulsed cyclic measurements (interrupted), permanently, or triggered
♦ Sensitivity adjustable in two stages
♦ Digital measurement value output in three conditions: field strength is positive, negative or close to zero
♦ Very short measurement time < 30 µs
♦ Very small power consumption (< 45 µA in pulse mode)
♦ Wide operating voltage range of 2.3 ... 5.5 V
♦ Extended temperature range from -40 to +125 °C

APPLICATIONS

♦ Position sensors
♦ Battery-operated revolution counters
♦ Safety-related controls

PACKAGES
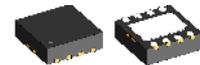
DFN8
3 mm x 3 mm x 0.9 mm
RoHS compliant

BLOCK DIAGRAM

http://www.ichaus.com
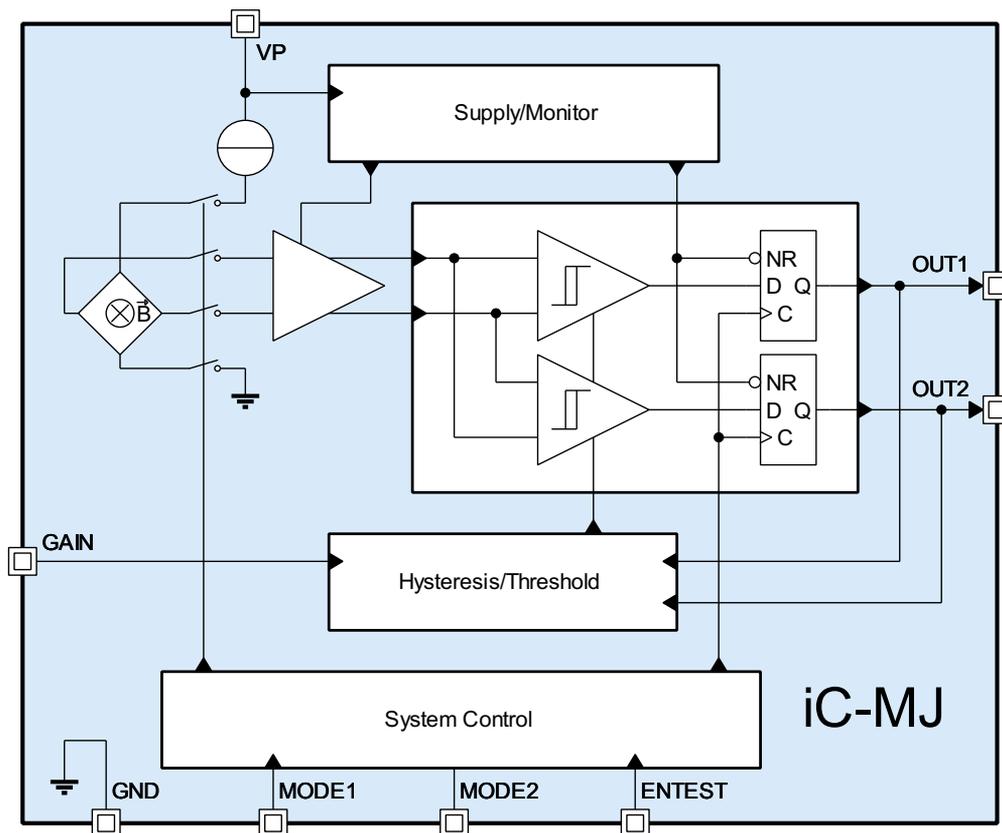
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DESCRIPTION

iC-MJ is a magnetic field sensor for determining the absolute field strength. The output proceeds in three conditions: positive, negative, or below the switching threshold which is adjustable for high and low sensitivity.

By applying the supply voltage, an initial measurement is running after a short start-up phase (regardless of the selected mode), which results will be displayed at the outputs OUT1 and OUT2 after no more than 30 µs.

This is followed by an energy-saving rest period when only the outputs and the internal timing generator remain active.

After the rest period, a new measurement is performed and the outputs adjusted to the result. This process is repeated as long as the supply voltage is supplied.

The automatic process can be switched: the field strength measurement can proceed either permanently, i.e. without rest period, or individually triggered by an external trigger pulse.

The switching hysteresis is depending on the latest initial state. Depending on that, successive measurements are evaluated.

PACKAGING INFORMATION DFN8-3x3

PIN CONFIGURATION
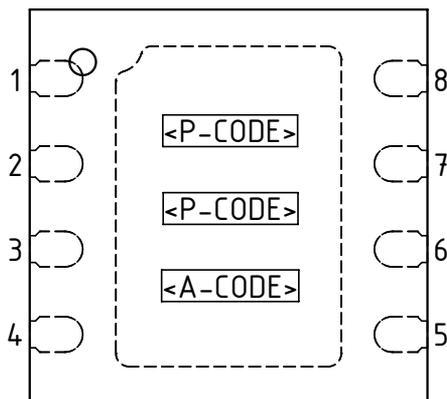
PIN FUNCTIONS

No.	Name	Function
1	ENTEST	Start test mode
2	MODE1	Measurement mode internal/triggered
3	VP	2.3... 5.5 V supply voltage
4	OUT1	Output 1
5	OUT2	Output 2
6	GND	Ground
7	GAIN	Sensitivity adjustment
8	MODE2	Measurement mode pulsed/continuous, trigger input
	BP [1]	Backside paddle

Orientation of IC top marking subject to changes: <P-CODE> = product code, <A-CODE> = assembly code;
1) Connecting the backside paddle is recommended by a single link to GND.

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PACKAGE DIMENSIONS

All dimensions given in mm.

RECOMMENDED PCB-FOOTPRINT

SIDE

TOP

BOTTOM

DETAIL Z
SCALE 20 : 1
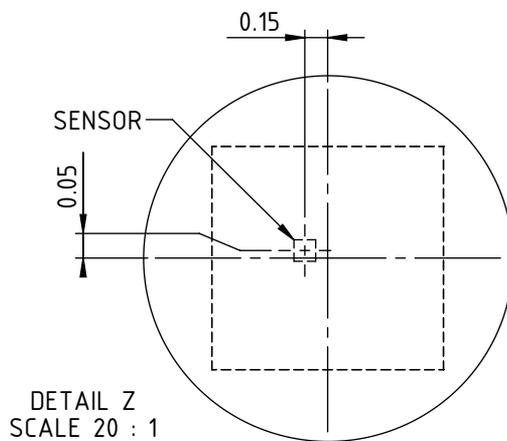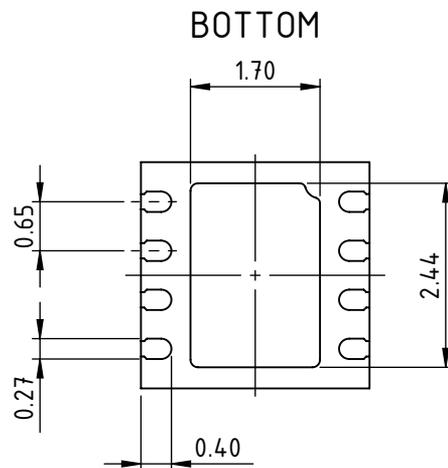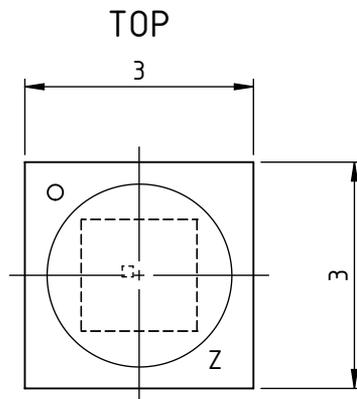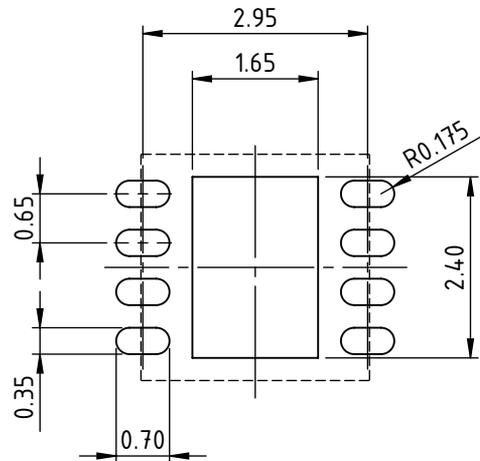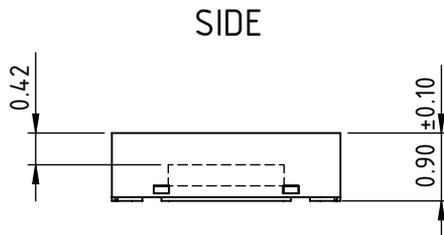
SENSOR

All dimensions given in mm. Tolerances of form and position according to JEDEC MO-229.
Tolerance of sensor pattern: ±0.10mm / ±1° (with respect to center of backside pad). drb_dfn8-3x3-2_mj_u_pack_1, 10:1

iC-MJ
LOW-POWER HALL SENSOR

ABSOLUTE MAXIMUM RATINGS

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

Item No.	Symbol	Parameter	Conditions	Min.	Max.	Unit
G001	VP	Voltage at VP		-0.4	6	V
G002	V()	Voltage at OUTx, GAIN, MODEx	V() $\leq$ VP	-0.4	6	V
G003	V(ENTEST)	Voltage at ENTEST		-0,4	6	V
G004	I()	Current in OUTx, GAIN, MODEx		-30	30	mA
G005	I(ENTEST)	Current in ENTEST, GAIN, MODEx		-1	1	mA
G006	Ilu()	Pulse current to all pins (Latch-Up immunity)	according to Jedec standard No.78; Ta = 25 °C, Pulswidth up to 10 ms, VP = VP_{max}, Vlu() = (-0.5...+1.5) x $Vpin()_{max}$	-100	100	mA
G007	Vd()	Susceptibility to ESD at all pins	HBM 100 pF discharged through 1.5 kΩ		2	kV
G008	Tj	Junction Temperature		-40	150	°C
G009	Ts	Storage Temperature Range		-40	150	°C

THERMAL DATA

Operating Conditions: VP = 2.3.... 5.5 V

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
T01	Ta	Operating Ambient Temperature Range		-40		125	°C
T02	Rthja	Thermal Resistance Chip/Ambient	surface mounted, thermal pad soldered to ca. 2 cm^2 heat sink		30		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.

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ELECTRICAL CHARACTERISTICS

Operating Conditions: VP = 2.3.... 5.5 V, TJ = - 40... 125 °C, unless otherwise stated

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Supply pin VP							
101	VP	operating voltage		2.3		5.5	V
102	I(VP)	average current consumption	pulse mode: MODE(2:1) = 00, VP = 2.3 V			35	µA
103	I(VP)	average current consumption	pulse mode: MODE(2:1) = 00, VP = 5.5 V			45	µA
104	I(VP)	average current consumption	continuous mode: MODE(2:1) = 10			500	µA
105	I(VP)	current consumption	during measurement phase			650	µA
106	I(VP)	current consumption	during idle phase			8	µA
107	I(VP)	current consumption	during waiting phase in trigger mode			100	nA
108	Q	required supply charge for one measurement cycle	VP $\leq$ 3.3 V			3.5	nC
109	V()$_{on}$	turn-on threshold VP, system power-on	increasing VP	2.0		2.3	V
110	V()$_{stby}$	turn-off threshold VP, system standby	decreasing VP	1.8		2.0	V
111	V()$_{hys,stby}$	threshold hysteresis of VP		100		300	mV
112	V()$_{off}$	turn-off threshold VP, system reset	decreasing VP	1.0		2.0	V
113	Vc()$_{hi}$	clamp voltage High at all pins (exept ENTEST)	Vc()$_{hi}$ = V() - V(VP), I() = 1 mA	0.3		1.6	V
114	Vc()$_{lo}$	clamp voltage Low	I() = -1 mA	-1.6		-0.3	V
Magnetic Characteristics							
201	H$_{on}$ B$_{on}$	upper magnetic threshold	increasing magnetic field strength, GAIN = High	10 12	16 20	24 30	kA/m mT
202	H$_{off}$ B$_{off}$	lower magnetic threshold	decresing magnetic field strength, GAIN = High	4 5	7 9	12 15	kA/m mT
203	H$_{hys}$ B$_{hys}$	magnetic thresold hysteresis	GAIN = High	6 7		12 15	kA/m mT
204	H$_{on}$ B$_{on}$	upper magnetic threshold	increasing magnetic field strength, GAIN = Low	24 30	38 48	60 76	kA/m mT
205	H$_{off}$ B$_{off}$	lower magnetic threshold	decreasing magnetic field strength, GAIN = Low	5 6	28 35	40 50	kA/m mT
206	H$_{hys}$ B$_{hys}$	magnetic thresold hysteresis	GAIN = Low	10 12		35 44	kA/m mT
Output pins OUT1, OUT2							
301	Vs()$_{hi}$	saturation voltage OUTx = High	V(OUTx) = V(VP) - V(), I(OUTx) = -0.75 mA			0.4	V
302	Vs()$_{lo}$	saturation voltage OUTx = Low	I(OUTx) = 0.75 mA			0.4	V
303	Isc()$_{hi}$	short-circuit current High	V(OUTx) = V(GND)	-30		-2	mA
304	Isc()$_{lo}$	short-circuit current Low	V(OUTx) = V(VP)	2		30	mA
305	t$_{rise}$	rise time V(OUTx)	CL = 50 pF			60	ns
306	t$_{fall}$	fall time V(OUTx)	CL = 50 pF			60	ns
input pins GAIN, MODE1, MODE2, ENTEST							
401	Vt()$_{hi}$	threshold voltage High		55		75	%VP
402	Vt()$_{lo}$	threshold voltage Low		25		45	%VP
403	Vt()$_{hys}$	hysteresis threshold voltage		10		40	%VP
404	Ilk()	leakage current	0 $\leq$ V() $\leq$ V(VP)	-100		100	nA
Dynamic behaviour							
501	t$_{RDY}$	start of first measurement	from power on, VP $\geq$ 2.3 V			30	µs
502	t$_{MEAS}$	measurement cycle	all operating modes	4		7	µs
503	t$_{MEAS}$	measurement cycle	from start of trigger edge			30	µs
504	t$_{CYCLE}$	time to next measurement	pulsed mode	80		140	µs
505	t$_{HOLD}$	hold time	triggered mode			20	µs
506	t$_{PULS}$	pulse width	triggered mode	1			µs

Description of Functions

Measurement process

After the operating voltage on VP exceeded the value $V()_{ON}$, the first measurement is implemented, regardless of the selected operation mode. Further performances of iC-MJ is depending on the operation mode, which is selected by the circuitry of MODE(1,2), as described in table 4.

MODE1	MODE2	Function
0	0	pulsed
0	1	continuous
1	$1 \rightarrow 0$	triggered: falling edge triggers measurement

Table 4: Different operating modes

At the outputs OUT(1,2), iC-MJ displays the result of the last magnetic field measurement. The outputs are retained even during the rest periods ("SLEEP" or "WAIT"). In pulsed and continuous operation, the switching thresholds and hysteresis of the current measurement are defined by the latest measurement values, so that they are subject to one coherent assessment.

A positive field means that the chip surface directs to a magnetic South Pole and the bottom to a North Pole. Thus, in this case, the field lines prevade the Hall sensor from bottom to top.

The condition OUT(2:1) = 00 is assigned from power-up until the completion of the first measurement (after t_{RDY}), then the outputs enter the condition of the appropriate magnetic field measurement, see table 5. A transition from 01 to 10 or vice versa thereby proceeds always via condition 11. If the supply voltage at VP falls below the threshold value $V()_{STBY}$, no further measurements are made. If the supply voltage at VP falls below the threshold value $V()_{OFF}$, iC-MJ is reset internally and the outputs are switched to OUT(2:1) = 00. Table 6 shows the performances of the iC-MJ at various operating voltages at VP.

OUT1	OUT2	Meaning
0	0	VP too small or start-up phase
0	1	positive field
1	0	negative field
1	1	no field

Table 5: Possible output values

VP	OUT(1:2)	Zustand
VP < 1,2 V	00	OFF
1,2 V < VP < 2,3 V	00 oder last value	no measurement, standby
VP > 2,3 V	01, 10 oder 11	measurement

Table 6: Performance with different operating voltages VP

The switching thresholds of the internal comparators can be determined via pin GAIN. If GAIN = 0 V, the switching thresholds are high: the magnetic field must be larger than in the more sensitive mode when GAIN is assigned to VP whereby the switching thresholds are reduced and the comparators switch even at smaller magnetic fields. Figure 1 shows the performance of the outputs in relation to the magnetic field, the switching points, and hysteresis (dashed lines). The performance for both GAIN settings is the equal.
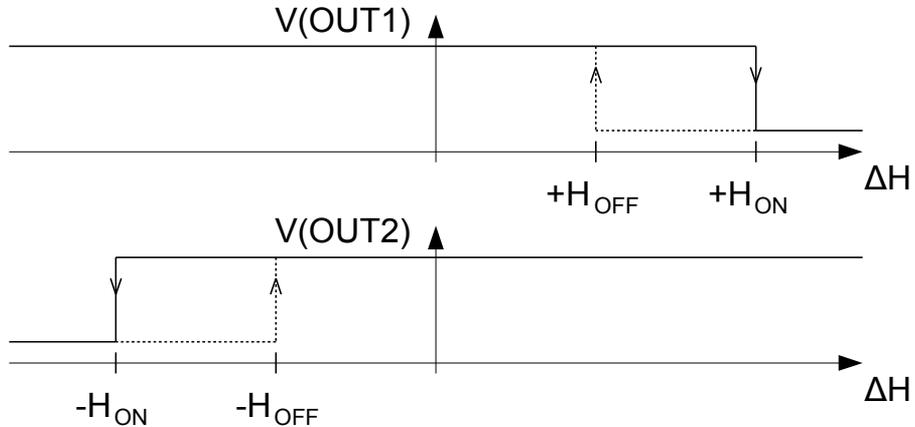
Figure 1: Switching outputs

Pulsed operation

If the pins MODE1 and MODE2 are assigned to GND, a power-saving rest period "SLEEP" is launched after each measurement. Rest period and subsequent measurement are repeated within the period t_{CYCLE}.
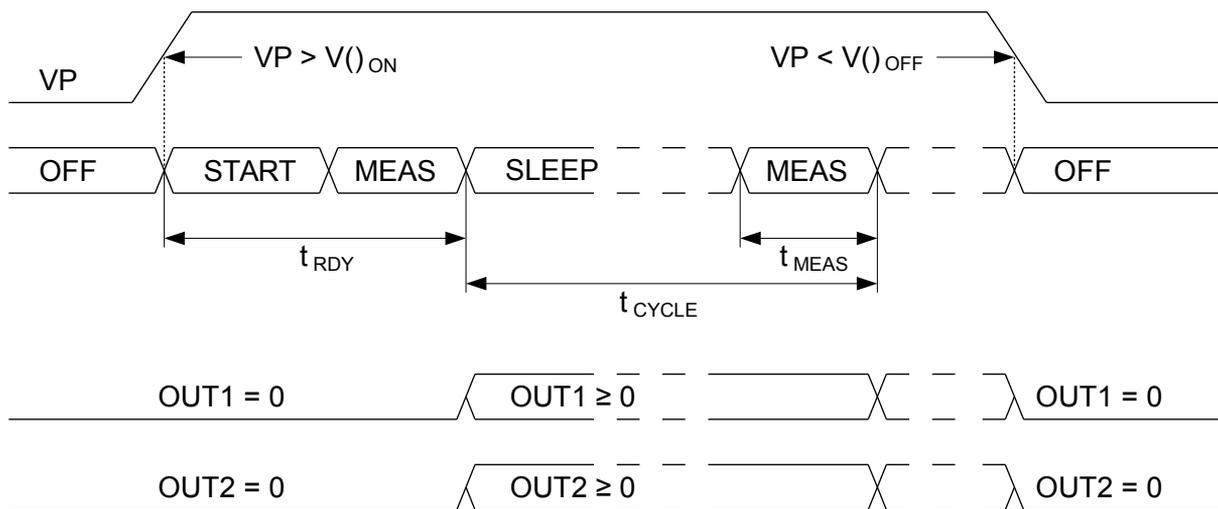
Figure 2: Measurement process in pulsed operation

Continuous Operation

If pin MODE2 is assigned to VP and MODE1 to GND, the measurements run uninterrupted consecutively and continuously. This results in a measurement process as shown in figure 3.
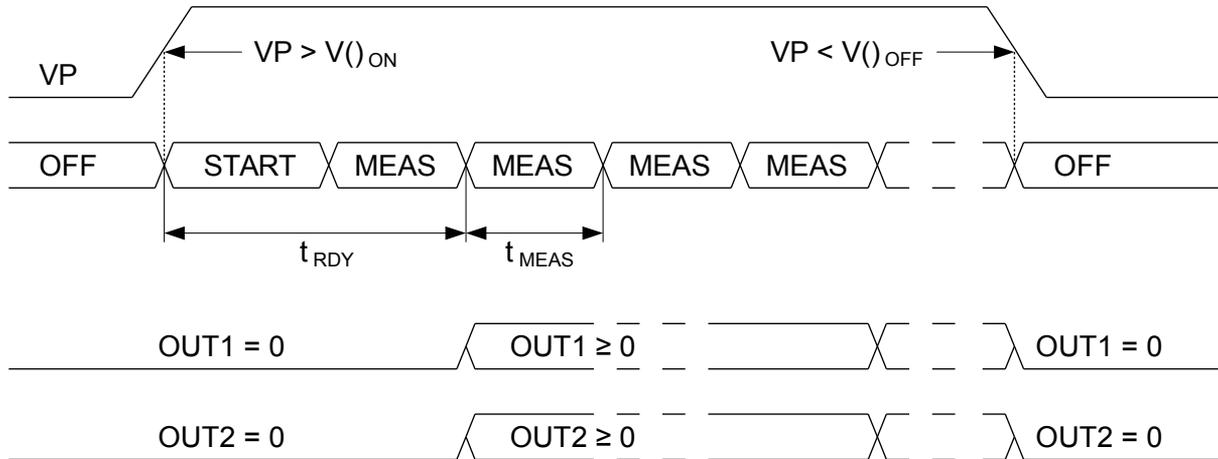
Figure 3: Measurement process in continuous operation

Triggered Operation

If pin MODE1 is assigned to VP, each measurement can be triggered individually. A falling edge at MODE2 triggers a measurement process and displays the result at outputs OUT(1,2). After each measurement, iC-MJ goes to standby mode "WAIT" until the next measurement is triggered. Note that no trigger signal is evaluated within the period t_{HOLD} and no supply voltage is monitored during standby of the triggered mode.
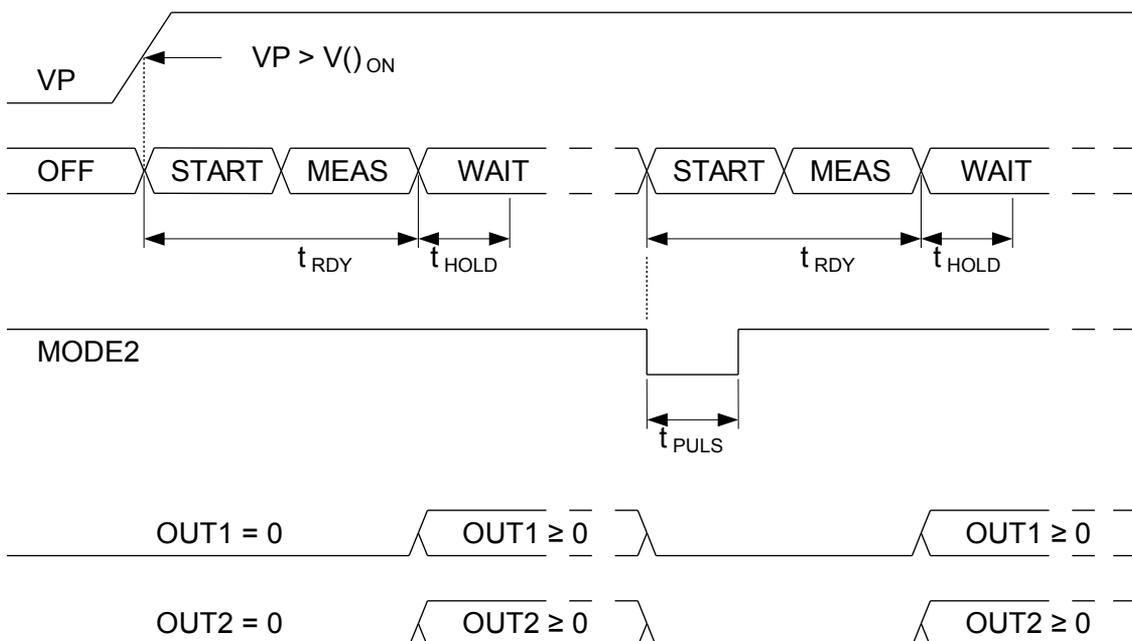
Figure 4: Measurement process in triggered operation

At the beginning of each measurement, the value of 00 is output at OUT(1:2). If the measurement was successful, the respective measurement value is output. If the supply voltage VP was not sufficiently high during the measurement, OUT(1:2) remains on the latest value or changes to 00 (depending on the VP).

Switching from triggered mode to another operation mode during operation time is not intended.

DESIGN REVIEW: Notes on Chip Functions

iC-MJ V		
No.	Function, Parameter/Code	Description and Application Notes
1	Triggered operating condition	Current consumption temporary increased after prolonged waiting phase. The supply current will fall below the specified value given in item 107 after a waiting time of about 120 sec.

Table 7: Notes on chip functions regarding iC-MJ chip release V

iC-MJ V2		
No.	Function, Parameter/Code	Description and Application Hints
1		No notes at time of printing.

Table 8: Notes on chip functions regarding iC-MJ chip release V2

REVISION HISTORY

Rel.	Rel. Date*	Chapter	Modification	Page
A1	2016-10-25		First (only in German) Release	

Rel.	Rel. Date*	Chapter	Modification	Page
B1	2017-06-02		Revised German / First English Release	

Rel.	Rel. Date*	Chapter	Modification	Page
C1	2017-12-06	FEATURES	Power consumption defined for pulse mode	1
		FEATURES	Operating temperature range added	1
		ABSOLUTE MAXIMUM RATINGS	ESD Susceptiblility increased to 2kV	4
		ABSOLUTE MAXIMUM RATINGS	G009 and G010: max values set to 150°C, former G008: obsolete (moved to "Thermal Data" section)	4
		THERMAL DATA	Section Thermal Data introduced with ambient temperature range and package thermal resistance	4

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

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ORDERING INFORMATION

Type	Package	Order Designation
iC-MJ	8-pin DFN, 3 mm x 3 mm RoHS compliant	iC-MJ DFN8-3x3

Please send your purchase orders to our order handling team:

Fax: +49 (0) 61 35 - 92 92 - 692
E-Mail: dispo@ichaus.com

For technical support, information about prices and terms of delivery please contact:

iC-Haus GmbH   **Tel.: +49 (0) 61 35 - 92 92 - 0**
Am Kuemmerling 18   **Fax: +49 (0) 61 35 - 92 92 - 192**
D-55294 Bodenheim   **Web: http://www.ichaus.com**
GERMANY   **E-Mail: sales@ichaus.com**

Appointed local distributors: http://www.ichaus.com/sales_partners