SW016
125 kHz reader IC for read-only RFID tags

DATA SHEET

Typical Applications

- ➔ **ID cards & keyrings**
- ➔ **Asset tags**
- ➔ **Contactless positionning systems**
- ➔ **Industrial transponder**
- ➔ **Medical transponder**
- ➔ **Animal transponder**

Features

- ➔ **Fully compatible with SW027 and market standard 125 kHz R/O chips.**
- ➔ **Generation of a carrier frequency, fixed by two external components, an antenna and a tuning capacitor.**
- ➔ **Short to long distance reading.**
- ➔ **Demodulation of the signal transmitted by read-only tag.**
- ➔ **Real time detection of the data integrity and extraction of the 40 bits ID code.**
- ➔ **Serial transmission of the ID code to a host micro-controller based system.**
- ➔ **"Power down" functions**

SOIC 18

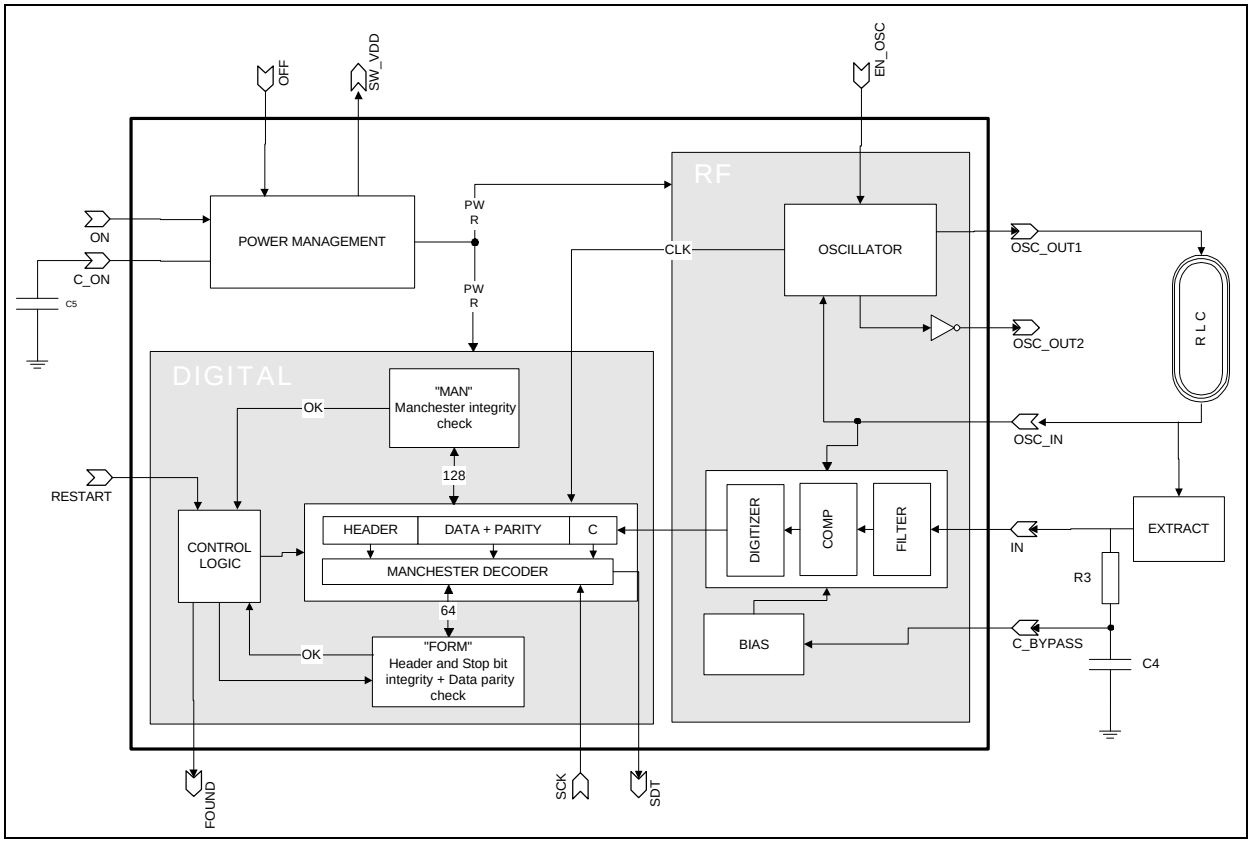
Product Description

The SW016 is a fully integrated 125 kHz RFID reader circuit. It is specially designed for being a space and cost efficient kernel IC of a read-only reading base station. It covers the digital real time functions and the analogue signal processing necessary to access most of the 64 bit R/O transponders available on the market.

Accessible by a standard micro-controller as an intelligent front end peripheral device, and connected to a coupling antenna system, it stands for a universal and dedicated monolithic radio frequency circuit which can operate at a distance of up to 10cm without the need of RF amplifying circuitry.

General functional description

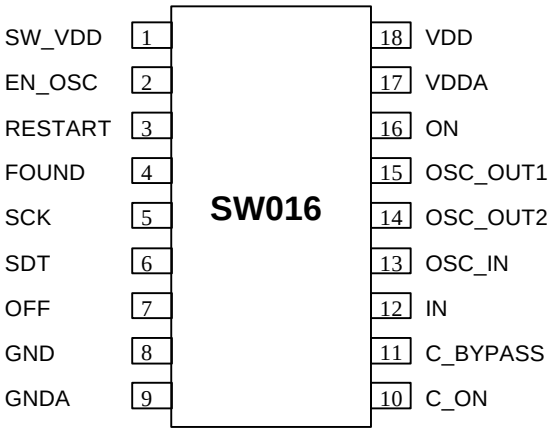
FUNCTIONAL DIAGRAM



I/O PORTS

Pin #	Name	I/O	Type
1.	SW_V_{DD}	out	analogue
2.	EN_OSC	in	digital
3.	Restart	in	digital
4.	Found	out	digital
5.	SCK	in	digital
6.	SDT	out	digital
7.	OFF	in	digital
8.	G_{ND}		power supply
9.	G_{NDA}		power supply
10.	C_ON	in	schmitt-trigger
11.	C_BYPASS	in	analogue
12.	IN	in	analogue
13.	OSC_IN	in	digital
14.	OSC_OUT2	out	power
15.	OSC_OUT1	out	power
16.	ON	in	digital
17.	VDDA		power supply
18.	V_{DD}		power supply

SW016 - top view



GENERAL PRINCIPLE

The device is controlled by and external microcontroller, which provides the necessary control signals to:

- ➔ Switch on and off (stand-by mode) SW016
- ➔ Reset SW016 to restart ID searching (RESTART)
- ➔ Send a SCK signal to clock the serial data bit stream provided by SW016

In return, it receives from SW016:

- ➔ The indication that an ID has been successfully read (FOUND)
- ➔ An error free ID number as a raw serial NRZ data
- ➔ Optionally a supply voltage controlled by a debounced On/Off switch (SW_VDD)

The power output drives an antenna (coil) tuned to the right frequency and connected to the OSC_OUT1 pin provides a 125 Khz carrier.

The amplitude-modulated signal due to the response of the tag is superimposed to the main carrier. A simple diode and an RC network provide a first level of filtering to leave out the high amplitude carrier from the small feedback signal.

Additional on-chip filtering provides further rejection of mains disturbance and remaining carrier before full synchronization, demodulation and error checking.

The processing of the digital data is controlled by a simple state machine. The following states are sequenced:

➔ **STATE1: receiving data from the filtering stage.**
This state is valid after RESTART, and until MANCHESTER integrity is checked valid (MANCHESTER OK mean that every two adjacent bits have opposite content). Internal 128 bit shift register is reset and then data acquisition is performed with a F/32 clock (F = carrier frequency).

➔ **STATE2: checking data format.**
This state is valid after STATE1 and after receiving a MANCHESTER OK signal. In this state, the incoming data is checked for correct parity and for header + stop bits integrity. If an error occurs on data packet, then the system goes back to STATE1. If OK, then STATE3.

➔ **STATE3: data transfer.**
This state follows STATE2 when no error on data packet. A FOUND signal is sent to Microcontroller and remains active while STATE3 is valid. Then MANCHESTER decoder is ready to stream out the 40 bits of raw data to the microcontroller.

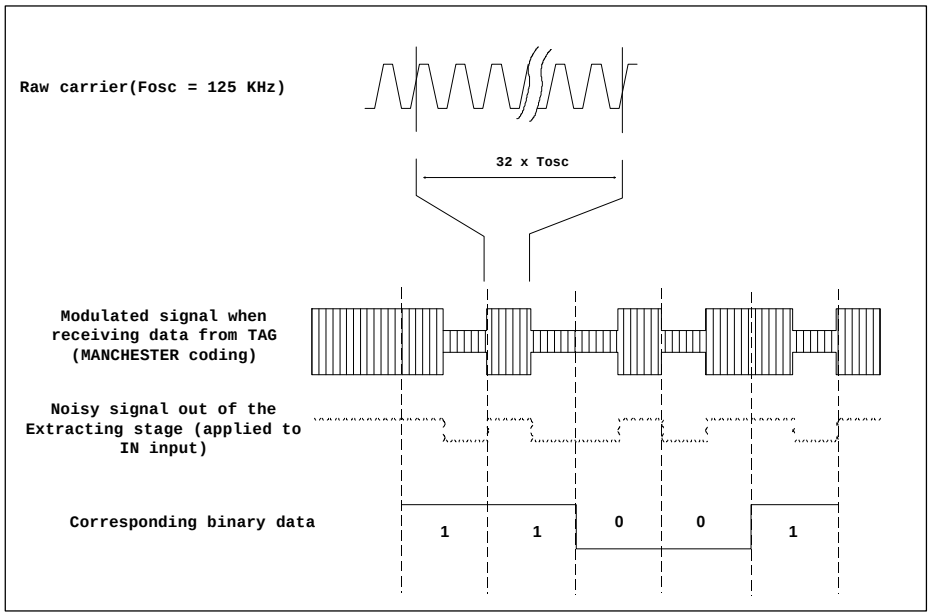
WARNING: STATE3 is a stable state: it does not change unless a proper RESTART command is provided.

For further details, refer to chapter “Data transfer protocol” and “Host command protocol”.

TIMING CHARACTERISTICS

▪ DECODING OF THE INPUT STREAM

According to Manchester coding the information read out from the tag is modulated as follows:



DATA TRANSFER PROTOCOL

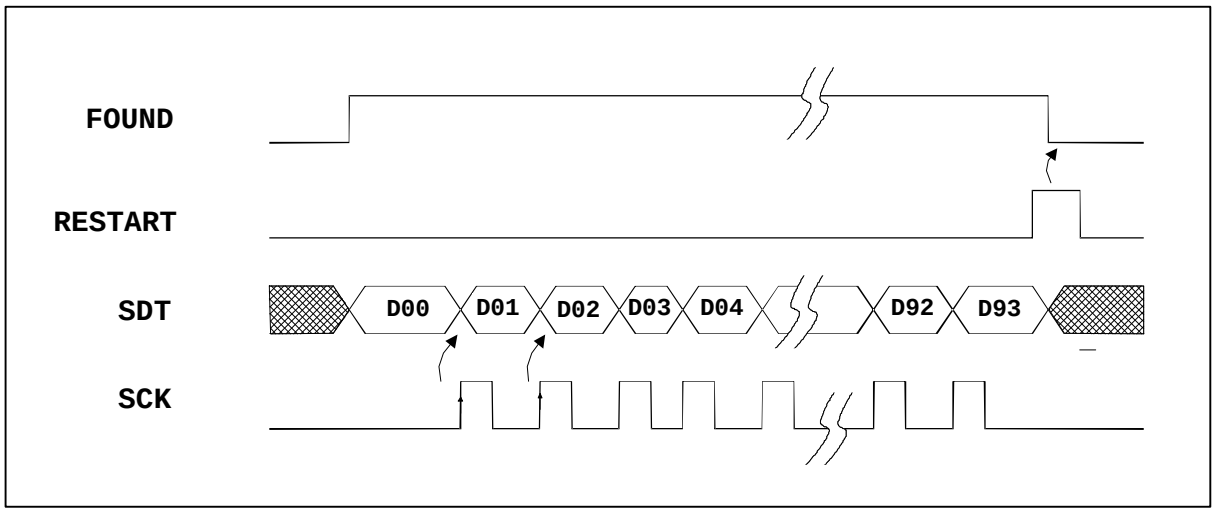
As specified before, SW016 is fully compatible with SW027 tag product. SW027 Memory array is organized as:

1	1	1	1	1	1	1	1	1
8 version bits or customer ID				D00	D01	D02	D03	P0
				D10	D11	D12	D13	P1
				D20	D21	D22	D23	P2
				D30	D31	D32	D33	P3
				D40	D41	D42	D43	P4
				D50	D51	D52	D53	P5
				D60	D61	D62	D63	P6
				D70	D71	D72	D73	P7
				D80	D81	D82	D83	P8
				D90	D91	D92	D93	P9
				PC0	PC1	PC2	PC3	C

- 9bits header
- 4data bit &
- associated even row parity bit

- 4 column even parity bits, no row parity bit
- C = 0 as a stop bit

While STATE3 is valid (FOUND command is active), SW016 is ready to provide the 40 bits of the ID data (D00 to D93) to the microcontoller, MSB first. Transfer protocol is described below. For timing characteristics, refer to AC electrical characteristics.



IMPORTANT NOTES:

- ➔ When FOUND turns active, the first bit of data is already present on the SDT output pin.
- ➔ Each changing low-to-high level of SCK provides the next bit on SDT.
- ➔ Only 39 SCK pulses are necessary to clock the 40 ID bits.

HOST COMMAND PROTOCOL

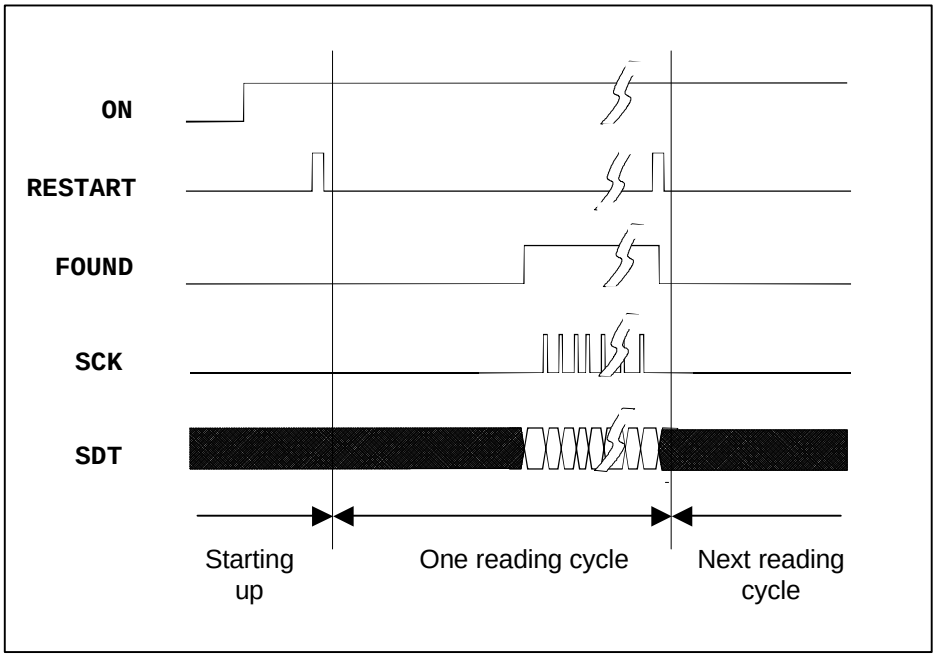
SW016 is typically used as a host peripheral in slave mode.

When powered, activation of SW016 will occur only when the host applies high level to ON pin.

The host will turn SW016 in acquisition mode (reading) by applying a RESTART command of the type: low/high/low. All readings should start only after such pulsed reset.

When a tag is read, SW016 returns a FOUND interruption to the host which can then clock out the 40 ID bits.

When done so, next reading will occur only after than a RESTART command is sent.



Electrical features

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions
Max storage temperature	$T_{STOREmax}$	+150 °C
Min storage temperature	$T_{STOREmin}$	-65 °C
Power supply voltage	V_{DD} &V_{DDA}	-0.3 to 7V
Voltage on any inputs		GND -0.3V to V_{DD} +0.3V
Digital input current	I_{IL}	±10 mA for Vin<GND or Vin>V_{DD}
Analogue input current	I_{IA}	±10 mA for Vin<GND or Vin>V_{DD}
Electrostatic discharge according to MIL-STD 883C method 3015	V_{ESD}	750 V(1)

(1) Stressed above these listed maximum ratings may cause permanent damage to the device. Exposure beyond specified conditions may affect device reliability or cause malfunction.

OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Units
Operating temperature	T_A	-40		+85	°C
Power supply voltage	V_{DD}	2.5		5.5	V

ELECTRICAL CHARACTERISTICS

➔ AC characteristics

(V_{DD} = 5 V ± 5%, T_A = +25 °C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
input capacitance	CI				10	pF
oscillator frequency	FOSC	2.5V≤V_{DD}≤5.5V		125		kHz
reading time	T Read	F OSC=125kHz	-	32.76	-	mS
SCK frequency	F SCK	Ton and Toff≥100nS	0		5	MHz
RESTART pulse length	tSCK		100			ns
Filter characteristics						
linear input	V_{IN}	peak to peak	$2.8*10^{-3}$		3	V
linear low cut-off frequency	LF		0.45	0.5	0.55	kHz
linear high cut-off frequency	HF		4.5	5	5.5	kHz
linear band-pass gain	BP G		54	60	66	dB
linear band-pass error	BP E				6	dB
linear filter order	F OR		-	4	-	
linear band-cut attenuation	A BC	by octave by decade	21 54	24 60	27 66	dB dB
linear signals to noise ratio	SN		54	60	66	dB

➔ DC characteristics

(V_{DD} = 5 V ± 5%, T_A = +25 °C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
stand-by current	I_{SB}	IN=GND			10	µA
output leakage current	I_{LO}	Vout=V_{DD} or GND			10	µA
input low voltage	V_{IL}	digital inputs	-0.3		0.5*V_{DD}	V
input high voltage	V_{IH}	digital inputs	0.5*V_{DD}		V_{DD}+0.3	V
Anti-spike delay	DRV DLY		100	200	300	nS
low threshold	V_{TL}	schmitt-trigger input	0.3*V_{DD}		0.4*V_{DD}	V
high threshold	V_{TH}	schmitt-trigger input	0.6*V_{DD}		0.7*V_{DD}	V
digital output low voltage	V_{OL}	output current=3mA			0.4	V
digital output high voltage	V_{OH}	output current=3mA	2.6			V
digital input resistance	R_{IL}	internal pull-down (except for IN_OSC)	50	100	150	kΩ
debounce resistance	R_{DEB}		50	100	150	kΩ
SW_V_{DD} current	ISW_V_{DD}		30			mA
SW_V_{DD} RDSon	RSW_V_{DD}	V_{DD} =5V V_{DD} =2.5V			7.7 13	Ω Ω
OSC_OUT 1/2 current	IOSC		-70		+70	mA
OSC_OUT 1/2 RDSon	ROSC	V_{DD} =5V V_{DD} =2.5V			3.3 5.6	Ω Ω

Application Note

USAGE OF PINS

ON:
High active logic input. Internally pulled down - Switch on the circuit through Schmitt trigger.
ON switches on the SW_Vdd output and also the digital parts.
The chip will NOT work unless the **ON** pin is High
The **ON** pin does not effect the antenna oscillator.

C_ON:
External capacitor used for debouncing of the on/off switch controlled by ON signal.

OFF:
High active logic input. Internally pulled down.
Switches-off the SW_ V_{DD} output. Refer to application note: “Remote power control”.

SW_ V_{DD}:
Positive voltage output, to supply an external micro-controller (up to 30 mA)
This output is controlled by ON and OFF pins. Refer to further application note: “Remote power control”.

EN_OSC:
High active logic input. Internally pulled down.
Enables the generating of the carrier. Used in off state to reduce power consumption in the application.

OSC_OUT1:
Power output.
LOW POWER: The frequency is determined by the value of the external inductance and tuning capacitor with feedback to OSC_IN.
HIGH POWER: The frequency is determined by the signal applied on OSC_IN.

When OSC_EN=low state OSC_OUT1 is in low state.

OSC_OUT2:
Power output.
In opposite phase compared to OSC_OUT1.
When OSC_EN=low state OSC_OUT2 is in low state.

OSC_IN:
Input frequency and phase for oscillator.
A square wave CMOS level signal can also be applied on this pin.

C_BYPASS:
External capacitor connection for decoupling internal analogue functions supply.
This pin is also used to bias IN pin trough an external RC network.

IN:
Analogue input for reading signal from ID of the tag.

RESTART:

High level active input. Internally pulled down.
High pulse will reset internal data register and returns to data acquisition mode (STATE1).
NOTE: RESTART pulse command should occur prior to any reading cycle.

FOUND:
Digital output.
High level on this output indicates that the ID code is correct.

SDT:
Digital output.
Serial data output for the decoded ID code.

SCK:
Digital input with pull down.
When FOUND is high, each low to high transition on this inputs acts on the SDT pin to output the next bit of the ID code. MSB is sent first.

HOW TO MAKE AN APPLICATION BOARD FOR LOW POWER APPLICATIONS

- **Tuning of the system**

The self-oscillating property of the system requires stable value for coil and tuning capacitor.
A ceramic capacitor NPO type or a polyethylene type is recommended

- **Detection diode**

To sustain the voltage on coil a 100 V detection diode is needed. 2 diodes BAV99 in series are recommended.

- **Other capacitors**

Ceramic types are suitable

- **Decoupling supply**

A 100 nF decoupling capacitor is recommended

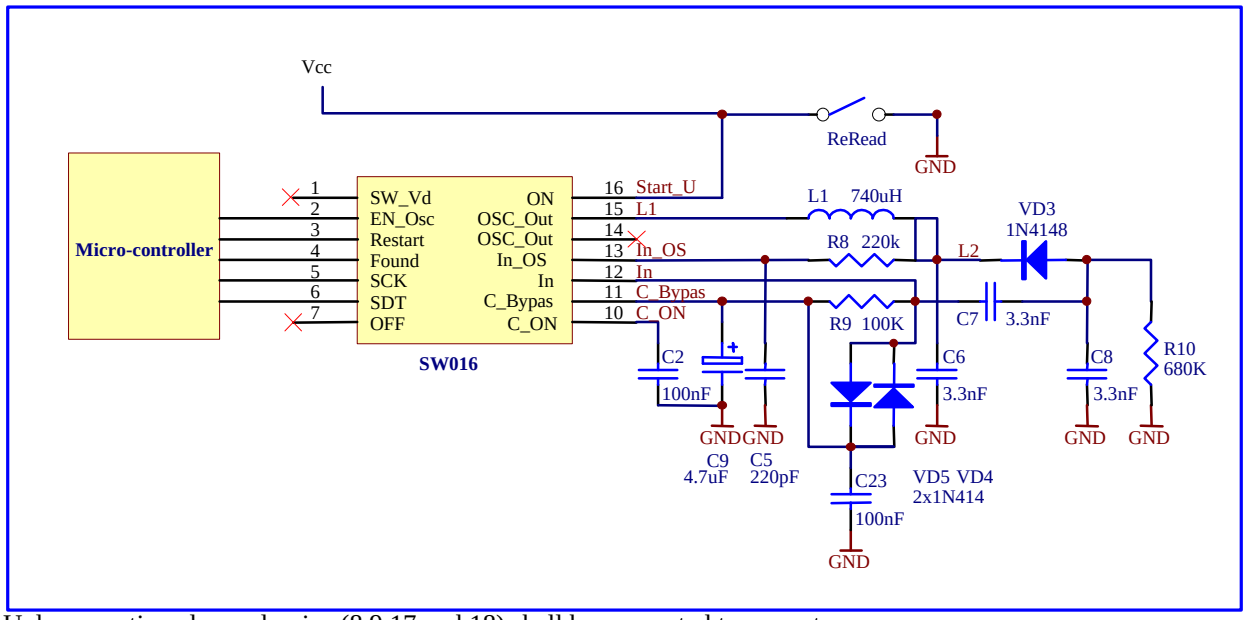
- **Interface signals**

Limitation of clock speed to 5 MHz
100 ns min stable state for all signals

- **Supply voltage**

Depending on application, 3 and 5 V supply is suitable

▪ APPLICATION SCHEMATICS



Note: Unless mentioned, supply pins (8,9,17 and 18) shall be connected to correct power.

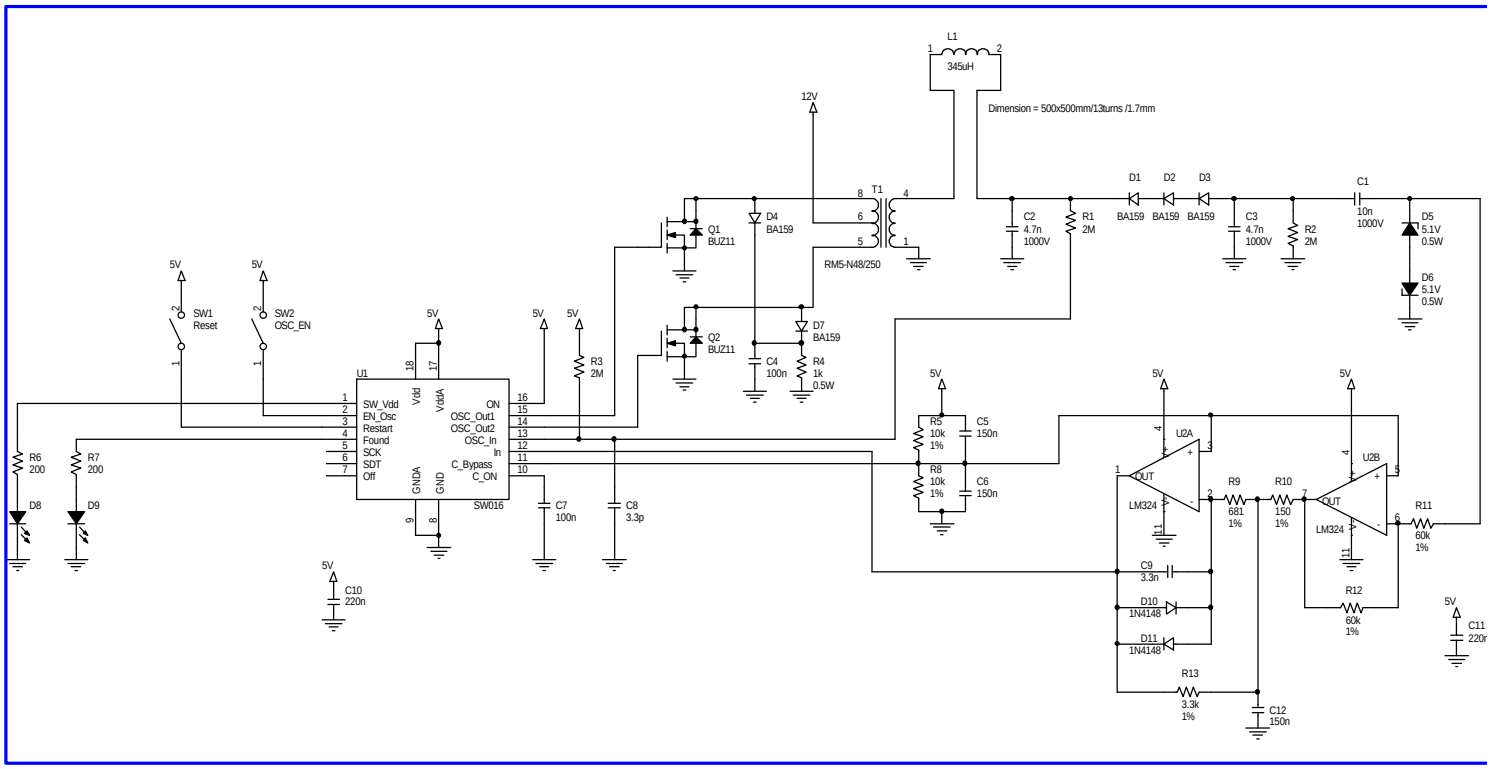
HOW TO MAKE AN APPLICATION BOARD FOR HIGH POWER APPLICATIONS

▪ RECOMMENDED COMPONENTS

Item	Quantity	Reference	Part	Power	Tolerance	Voltage	Manufacturer
1	1	C1	10n			1000V	
2	2	C2, C3	4.7n			1000V	
3	2	C4, C7	100n			63V	
4	3	C5, C6, C12	150n			63V	
5	1	C8	3.3p			63V	
6	1	C9	3.3n			63V	
7	2	C10, C11	220n			63V	
8	5	D1-D4, D7	BA159				
9	2	D5, D6	5.1V	0.5W			
10	2	D8, D9	LED				
11	2	D10, D11	1N4148				
12	1	L1	345ì H				
13	2	Q1, Q2	BUZ11				

Item	Quanti	Reference	Part	Power	Tolerance	Voltage	Manufacturer
14	3	R1-R3	2M	0.25W	5%		
15	1	R4	1K	0.5W	5%		
16	2	R5, R8	10K	0.25W	1%		
17	2	R6, R7	200	0.25W	5%		
18	1	R9	681	0.25W	1%		
19	1	R10	150	0.25W	1%		
20	2	R11, R12	60K	0.25W	1%		
21	1	R13	3.3K	0.25W	1%		
22	2	SW1, SW2	switch				
23	1	T1	RM5-N48/250, 3 x 8 turns ø 0.74 coated wire				Siemens, Matsushita Components
24	1	U1	SW016				
25	1	U2	LM324				

- **APPLICATION SCHEMATICS**



REMOTE POWER CONTROL

SW016 shows specific power management functionalities that can be used for power saving. These functions are controlled by ON and OFF commands.

GENERAL SWITCHING: This is performed by ON command (high active logic). ON can also acts like a general reset of the system by applying a low-then-high command. ON command is performed through a SCHMITT trigger stage.

µC POWER SUPPLY: SW016 can supply power to the microcontoller (5V max) through SW_VDD ouput. SW_VDD is supplied as soon as ON is active.

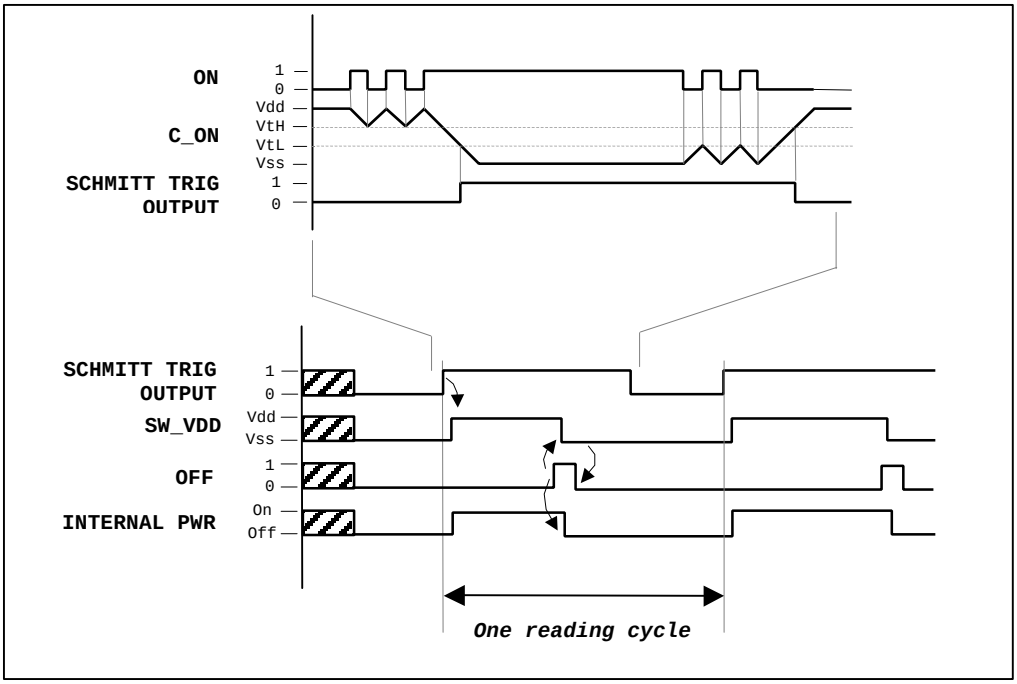
SYSTEM AUTO-OFF: The whole system power can be turned-off by microcontoller applying an OFF command to SW016 input. Therefore SW_output and internal SW016 power is disabled but the register contents are not cleared until RESTART is activated. Besides, OFF does not effect the antenna oscillator.

- **APPLICATION: "Remote power control"**

As described in the schematics below, for any use of the remote switch-off function (low power applications), the following sequence shall be applied:

➔ Turn system power on.
➔ Put ON pin to high level: this will supply power to microcontoller and SW016 internal functions. (OFF should be kept at low level) .
➔ When reading sequence is done, apply high level to OFF pin to power-off micro and disable SW016 internal functions.

Note that this is a stable state and can only be reset by reseting ON command.

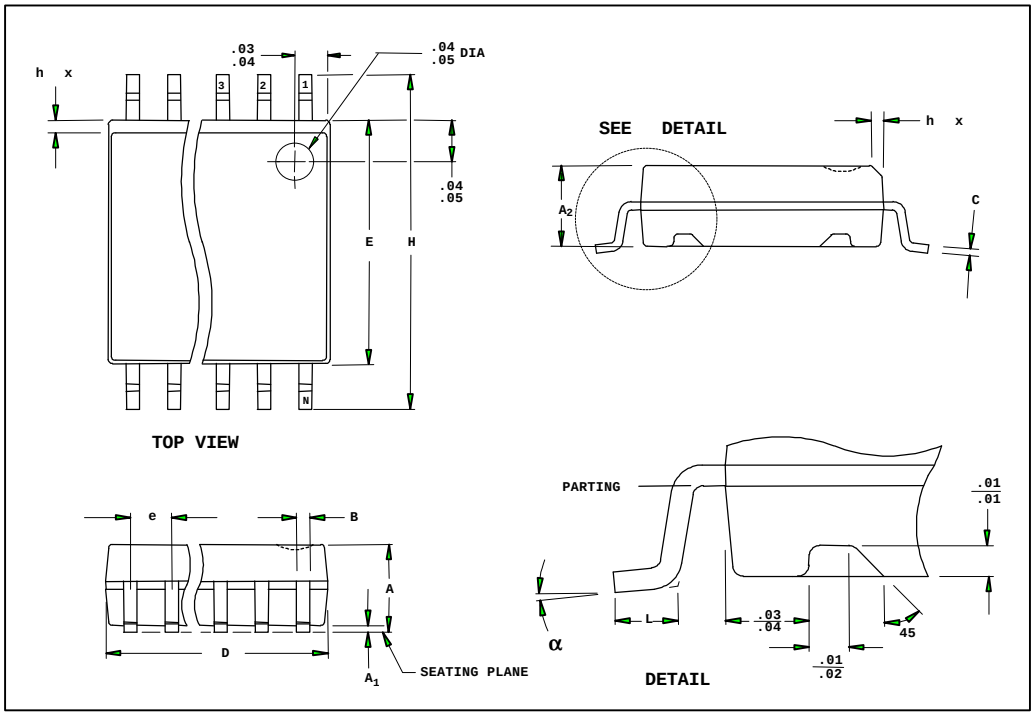


Ordering information

Product form	Order Code
Ceramic DIL (for sampling only)	SW016F-DC
SOIC 18 plastic	SW016F-T

Mechanical Characteristics

SOIC 18 package :



SYMBOL	DIMENSIONS (in mm)		
	MIN	TYP	MAX
A	2.46	2.56	2.64
A1	0.127	0.22	0.29
A2	2.29	2.34	2.39
B	035	0.41	0.48
C	0.23	0.25	0.32
D	SEE VARIATION		

SYMBOL	DIMENSIONS (in mm)		
	MIN	TYP	MAX
E	7.42	7.52	7.59
e	1.27 BSC		
H	10.16	10.31	10.41
h	0.25	0.33	0.41
L	0.61	0.81	1.02
α	0°	5°	8°

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