

## Read Only Contactless Identification Device

### Description

The EM4100 (previously named H4100) is a CMOS integrated circuit for use in electronic Read Only RF Transponders. The circuit is powered by an external coil placed in an electromagnetic field, and gets its master clock from the same field via one of the coil terminals. By turning on and off the modulation current, the chip will send back the 64 bits of information contained in a factory pre-programmed memory array.

The programming of the chip is performed by laser fusing of polysilicon links in order to store a unique code on each chip.

The EM4100 has several metal options which are used to define the code type and data rate. Data rates of 64, 32 and 16 periods of carrier frequency per data bit are available. Data can be coded as Manchester, Biphase or PSK.

Due to low power consumption of the logic core, no supply buffer capacitor is required. Only an external coil is needed to obtain the chip function. A parallel resonance capacitor of 74 pF is also integrated.

### Features

- 64 bit memory array laser programmable
- Several options of data rate and coding available
- On chip resonance capacitor
- On chip supply buffer capacitor
- On chip voltage limiter
- Full wave rectifier on chip
- Large modulation depth due to a low impedance modulation device
- Operating frequency 100 - 150 kHz
- Very small chip size convenient for implantation
- Very low power consumption

### Applications

- Logistics automation
- Anticounterfeiting
- Access control
- Industrial transponder

### Typical Operating Configuration

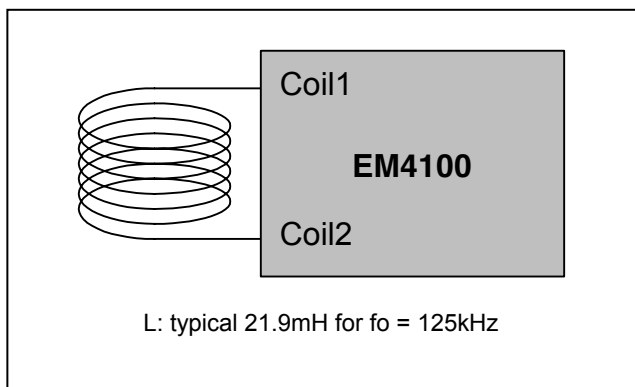


Fig. 1

### Pin Assignment

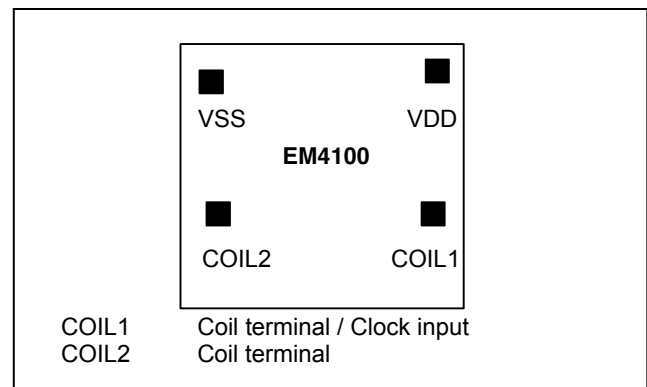


Fig. 2



## Absolute Maximum Ratings

| Parameter   | Symbol      | Conditions        |
|---|-------------|-------------------|
| Maximum DC Current forced on COIL1 & COIL2                  | $I_{COIL}$  | $\pm 30\text{mA}$ |
| Power Supply  | $V_{DD}$    | -0.3 to 7.5V      |
| Storage Temp. Die form                                      | $T_{store}$ | -55 to +200°C     |
| Storage Temp. PCB form                                      | $T_{store}$ | -55 to +125°C     |
| Electrostatic discharge maximum to MIL-STD-883C method 3015 | $V_{ESD}$   | 1000V             |

Stresses above these listed maximum ratings may cause permanent damage to the device. Exposure beyond specified operating conditions may affect device reliability or cause malfunction.

## Operating Conditions

| Parameter            | Symbol     | Min. | Typ. | Max. | Units |
|----------------------|------------|------|------|------|-------|
| Operating Temp.      | $T_{op}$   | -40  |      | +85  | °C    |
| Maximum Coil Current | $I_{COIL}$ |      |      | 10   | mA    |
| AC Voltage on Coil   | $V_{coil}$ | 3    | 14*  |      | Vpp   |
| Supply Frequency     | $f_{coil}$ | 100  |      | 150  | kHz   |

\*) The AC Voltage on Coil is limited by the on chip voltage limitation circuitry. This is according to the parameter  $I_{coil}$  in the absolute maximum ratings.

## Handling Procedures

This device has built-in protection against high static voltages or electric fields; however due to the unique properties of this device, anti-static precautions should be taken as for any other CMOS component.

## System Principle

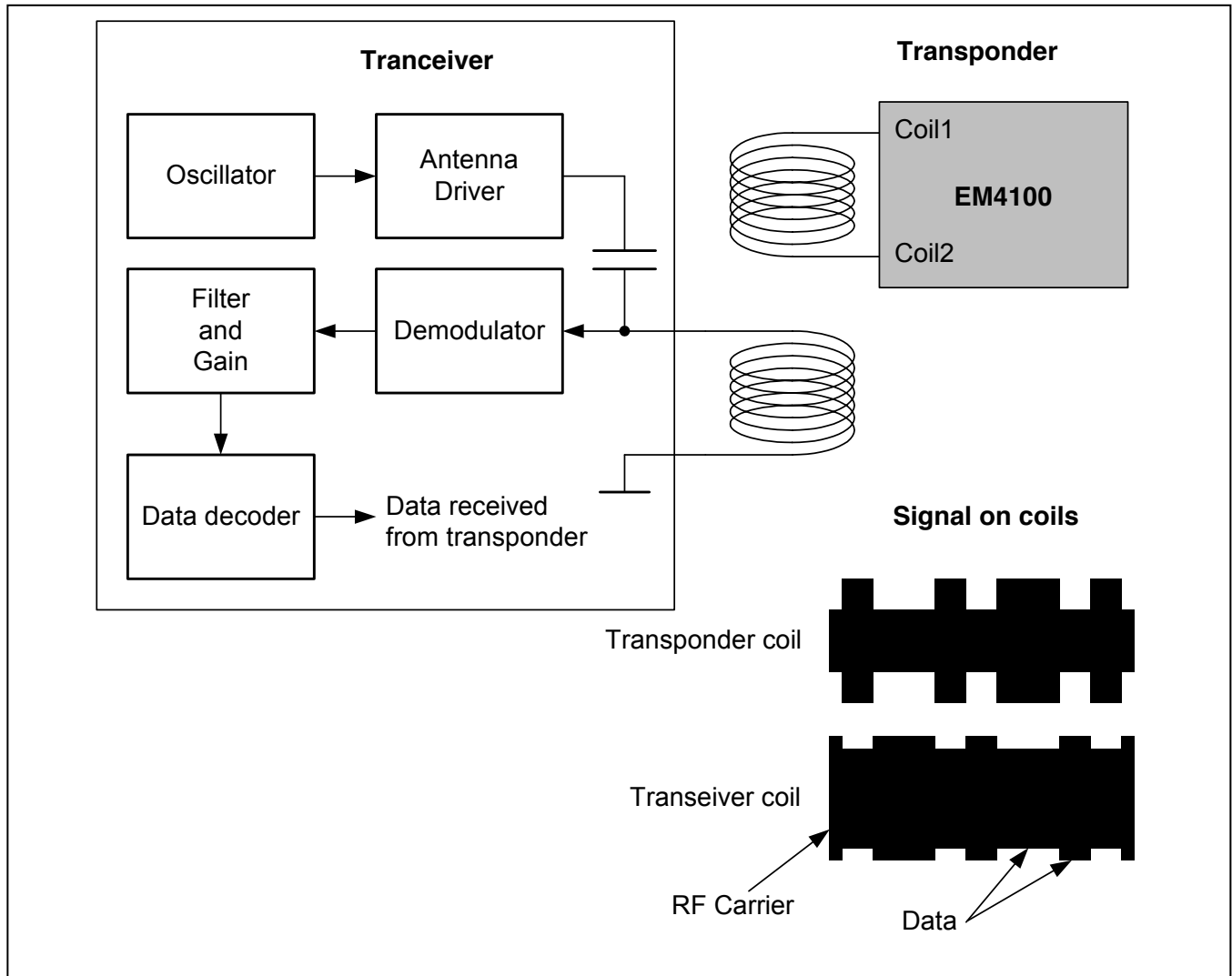


Fig. 3



## Electrical Characteristics

$V_{DD} = 1.5V$ ,  $V_{SS} = 0V$ ,  $f_{C1} = 134kHz$  square wave,  $T_a = 25^{\circ}C$

$V_{C1} = 1.0V$  with positive peak at  $V_{DD}$  and negative peak at  $V_{DD} - 1V$  unless otherwise specified

| Parameter                                | Symbol        | Test Conditions  | Min. | Typ.  | Max.      | Units   |
|--|---------------|--|------|-------|-----------|---------|
| Supply Voltage                           | $V_{DD}$      |  | 1.5  |       | 1)<br>1.5 | V       |
| Rectified Supply Voltage                 | $V_{DDREC}$   | $V_{COIL1} - V_{COIL2} = 2.8$ VDC<br>Modulator switch = "ON" | 1.5  |       |           | V       |
| Coil1 - Coil2 Capacitance                | $C_{res}$     | $V_{coil}=100mV_{RMS}$ $f=10kHz$                             |      | 74 2) |           | pF      |
| Power Supply Capacitor                   | $C_{sup}$     |  |      | 120   |           | pF      |
| <b>Biphase &amp; Manchester Versions</b> |               |  |      |       |           |         |
| Supply Current                           | $I_{DD}$      |  |      | 0.63  | 1.5       | $\mu A$ |
| C2 pad Modulator ON voltage drop         | $V_{ONC2}$    | $V_{DD}=1.5V$ $I_{VDDC2}=100\mu A$ with ref. to $V_{DD}$     | 0.9  | 1.1   | 1.3       | V       |
|  |               | $V_{DD}=5.0V$ $I_{VDDC2}=1mA$ with ref. to $V_{DD}$          | 2.1  | 2.3   | 2.8       | V       |
| C1 pad Modulator ON voltage drop         | $V_{ONC1}$    | $V_{DD}=5.0V$ $I_{VDDC1}=1mA$ with ref. to $V_{DD}$          | 2.1  | 2.3   | 2.8       | V       |
| <b>PSK Version</b>                       |               |  |      |       |           |         |
| Supply Current PSK                       | $I_{DDPSK}$   |  |      | 0.92  | 2         | $\mu A$ |
| C2 pad Modulator ON voltage drop         | $V_{ONC2PSK}$ | $V_{DD}=1.5V$ $I_{VDDC2}=100\mu A$ with ref. to $V_{DD}$     | 0.3  | 0.6   | 0.9       | V       |

Note 1) The maximum voltage is defined by forcing 10mA on COIL1 - COIL2

Note 2) The tolerance of the resonant capacitor is  $\pm 15\%$  over the whole production.  
Optional reduced tolerance on request  
On a wafer basis, the tolerance is  $\pm 2\%$

## Timing Characteristics

$V_{DD} = 1.5V$ ,  $V_{SS} = 0V$ ,  $f_{coil} = 134kHz$  square wave,  $T_a = 25^{\circ}C$

$V_{C1} = 1.0V$  with positive peak at  $V_{DD}$  and negative peak at  $V_{DD} - 1V$  unless otherwise specified

Timings are derived from the field frequency and are specified as a number of RF periods.

| Parameter       | Symbol    | Test Conditions     | Value      | Units      |
|-----------------|-----------|---------------------|------------|------------|
| Read Bit Period | $T_{rdb}$ | depending on option | 64, 32, 16 | RF periods |

## Timing Waveforms

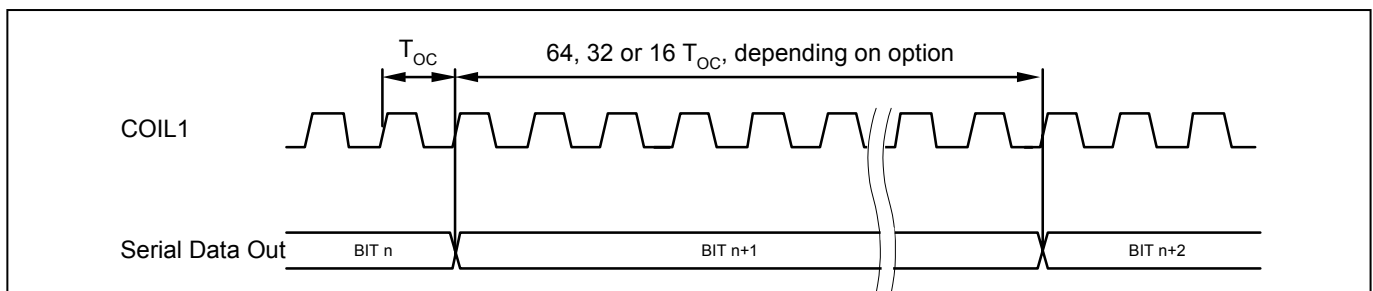


Fig. 4



## Block Diagram

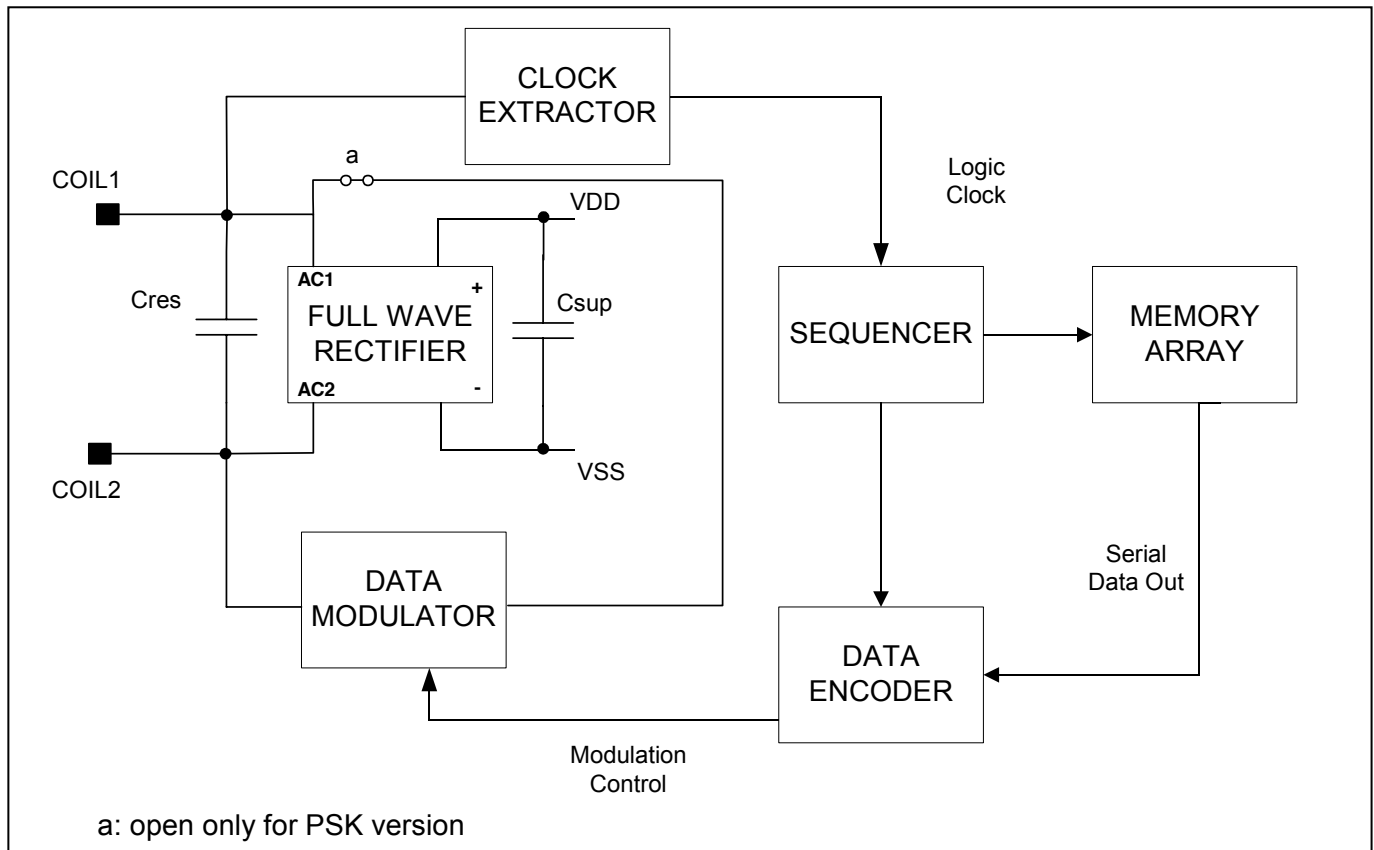


Fig. 5

## Functional Description

### General

The EM4100 is supplied by means of an electromagnetic field induced on the attached coil. The AC voltage is rectified in order to provide a DC internal supply voltage. When the last bit is sent, the chip will continue with the first bit until the power goes off.

### Full Wave Rectifier

The AC input induced in the external coil by an incident magnetic field is rectified by a Graetz bridge. The bridge will limit the internal DC voltage to avoid malfunction in strong fields.

### Clock Extractor

One of the coil terminals (COIL1) is used to generate the master clock for the logic function. The output of the clock extractor drives a sequencer.

### Sequencer

The sequencer provides all necessary signals to address the memory array and to encode the serial data out.

Three mask programmed encoding versions of logic are available. These three encoding types are Manchester, biphasic and PSK. The bit rate for the first and the second type can be 64 or 32 periods of the field frequency. For the PSK version, the bit rate is 16.

The sequencer receives its clock from the COIL1 clock extractor and generates every internal signal controlling the memory and the data encoder logic.

### Data Modulator

The data modulator is controlled by the signal Modulation Control in order to induce a high current in the coil. In the PSK version, only COIL2 transistor drives this high current. In the other versions, both coil1 and coil2 transistors drive it to Vdd. This will affect the magnetic field according to the data stored in the memory array.

### Resonance Capacitor

This capacitor can be trimmed in factory by 0.5pf steps to achieve the absolute value of 74pf typically. This option, which is on request, allows a smaller capacitor tolerance on the whole of the production.



### Memory Array for Manchester & Bi-Phase encoding ICs

The EM4100 contains 64 bits divided in five groups of information. 9 bits are used for the header, 10 row parity bits (P0-P9), 4 column parity bits (PC0-PC3), 40 data bits (D00-D93), and 1 stop bit set to logic 0.

|                               |     |     |     |     |    |     |     |     |     |               |                      |
|-------------------------------|-----|-----|-----|-----|----|-----|-----|-----|-----|---------------|----------------------|
| 1                             | 1   | 1   | 1   | 1   | 1  | 1   | 1   | 1   | 1   | 9 header bits |                      |
| 8 version bits or customer ID | D00 | D01 | D02 | D03 | P0 | D20 | D21 | D22 | D23 | P2            |                      |
|                               | D10 | D11 | D12 | D13 | P1 |     | D30 | D31 | D32 | D33           | P3                   |
| 32 data bits                  | 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            |                      |
|                               | D90 | D91 | D92 | D93 | P9 | PC0 | PC1 | PC2 | PC3 | S0            |                      |
|                               |     |     |     |     |    |     |     |     |     |               | 10 line parity bits  |
|                               |     |     |     |     |    |     |     |     |     |               | 4 column parity bits |

The header is composed of the 9 first bits which are all mask programmed to "1". Due to the data and parity organisation, this sequence cannot be reproduced in the data string. The header is followed by 10 groups of 4 data bits allowing 100 billion combinations and 1 even row parity bit. Then, the last group consists of 4 event column parity bits without row parity bit. S0 is a stop bit which is written to "0"

Bits D00 to D03 and bits D10 to D13 are customer specific identification.

These 64 bits are outputted serially in order to control the modulator. When the 64 bits data string is outputted, the output sequence is repeated continuously until power goes off.

### Memory Array for PSK encoding ICs

The PSK coded IC's are programmed with odd parity for P0 and P1 and always with a logic zero.

The parity bits from P2 to P9 are even.

The column parity PC0 to PC3 are calculated including the version bits and are even parity bits.

### Code Description

#### Manchester

There is always a transition from ON to OFF or from OFF to ON in the middle of bit period. At the transition from logic bit "1" to logic bit "0" or logic bit "0" to logic bit "1" the phase change. Value high of data stream presented below modulator switch OFF, low represents switch ON (see Fig. 6).

#### Biphase Code

At the beginning of each bit, a transition will occur. A logic bit "1" will keep its state for the whole bit duration and a logic bit "0" will show a transition in the middle of the bit duration (see Fig. 7).

#### PSK Code

Modulation switch goes ON and OFF alternately every period of carrier frequency. When a phase shift occurs, a logical "0" is read from the memory. If no shift phase occurs after a data rate cycle, a logical "1" is read (see Fig. 8).

### Manchester Code

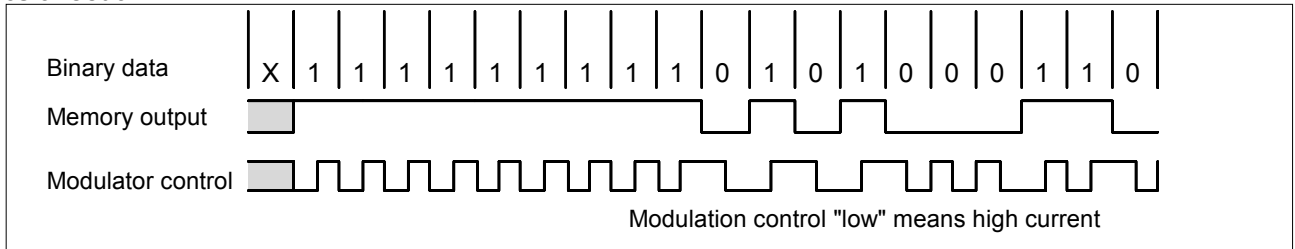


Fig. 6

### Biphase Code

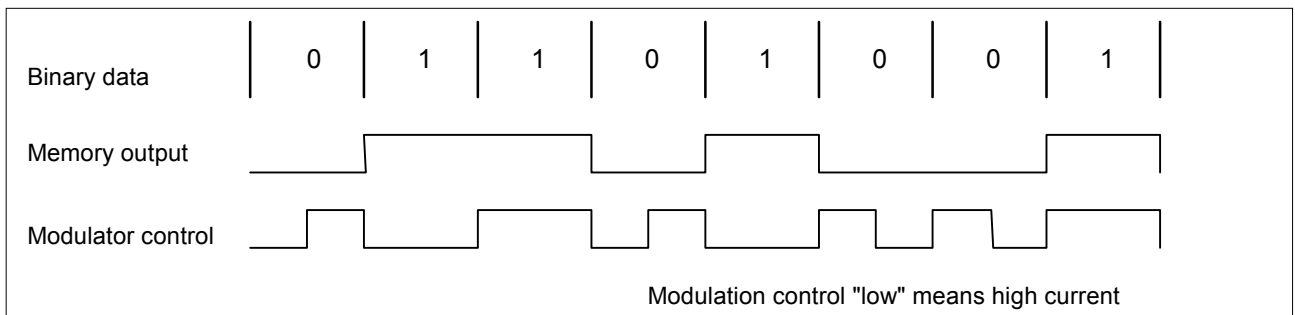


Fig. 7

## PSK Code

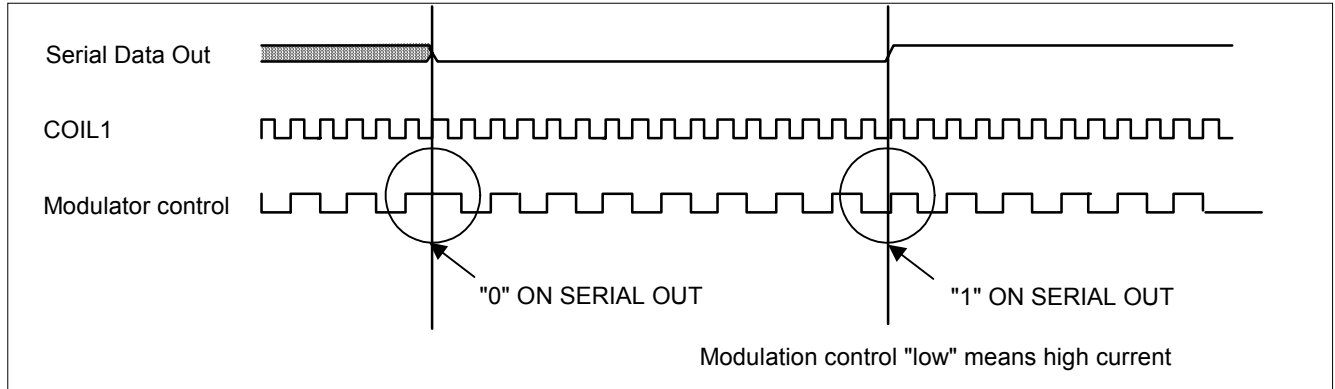


Fig. 8

## Typical Performance Characteristics

### Typical Capacitor Variation versus Temperature

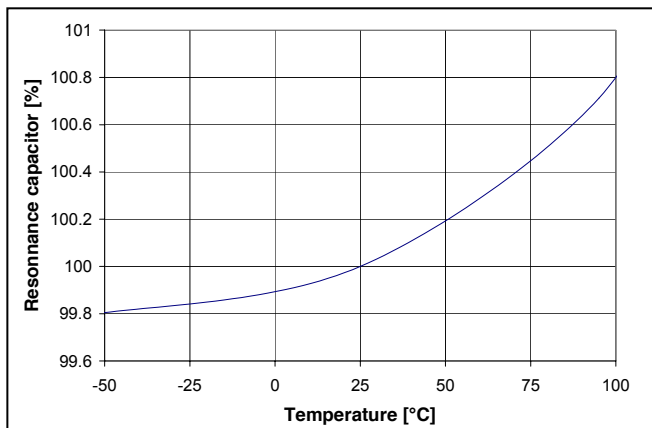


Fig. 9

### Dynamic Consumption Versus temperature with V<sub>dd</sub>-V<sub>ss</sub>=1.5V

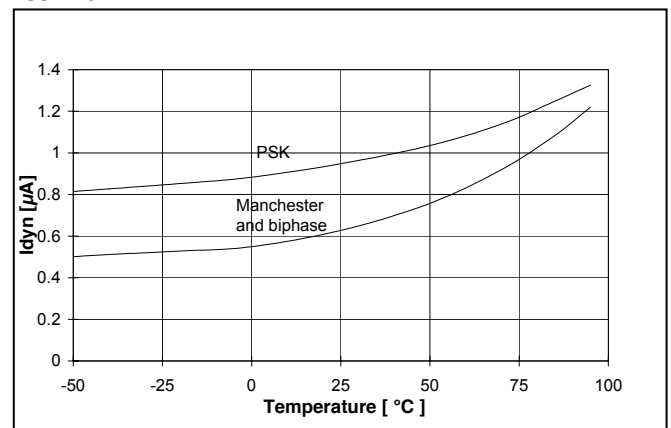


Fig. 10

### L versus Resonance Frequency versus for a typical coil capacitance of 74 pf

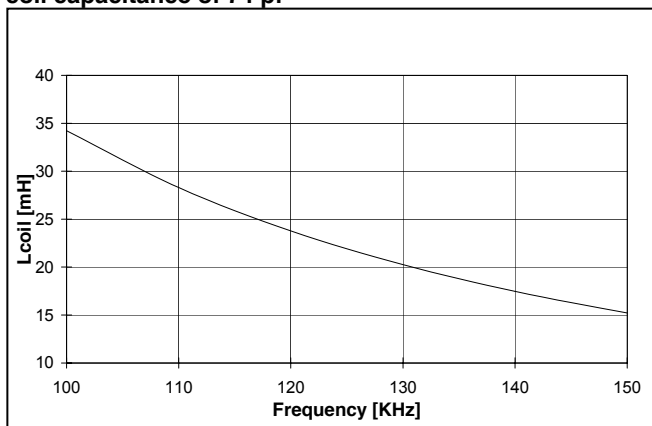


Fig. 11

### Rectified Voltage versus temperature for V<sub>coil2</sub>-V<sub>coil1</sub>=2.8V

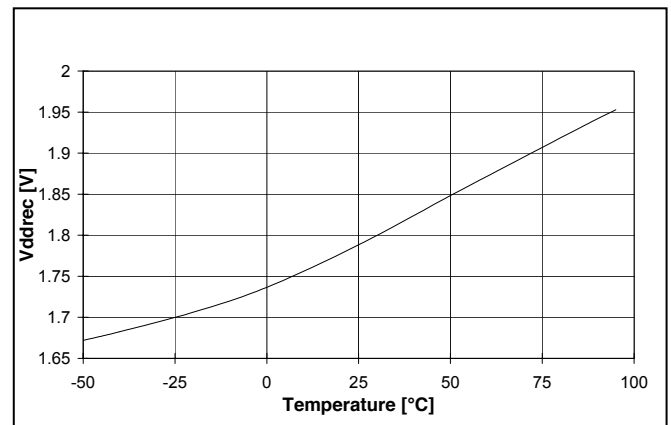


Fig. 12



## CHIP Dimensions

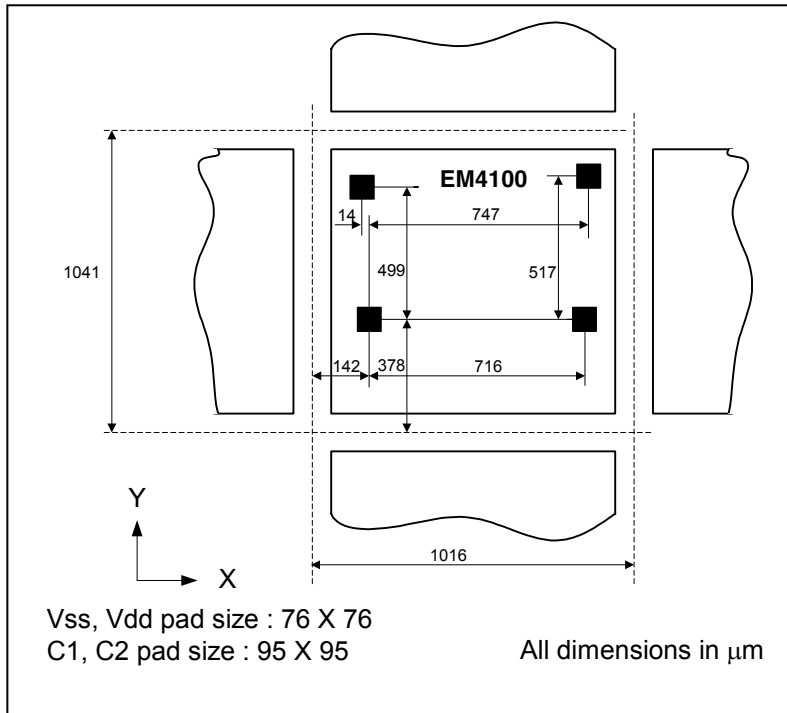


Fig. 13

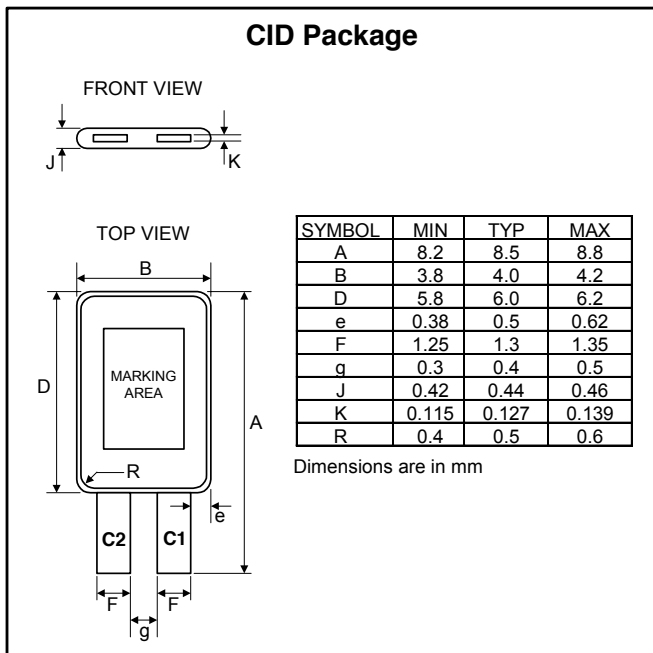


Fig. 14

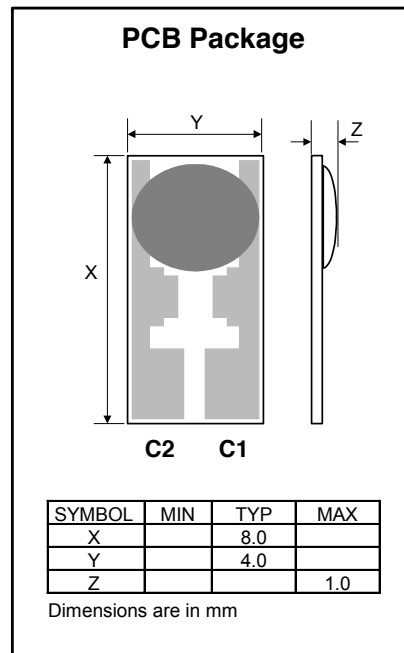


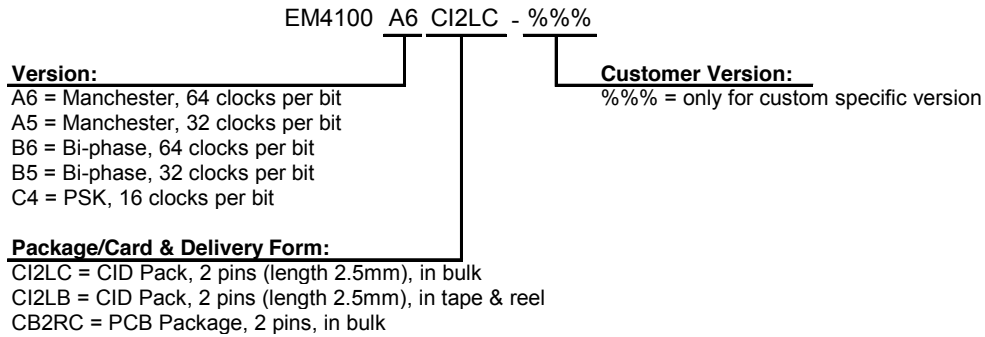
Fig. 15



## Ordering Information

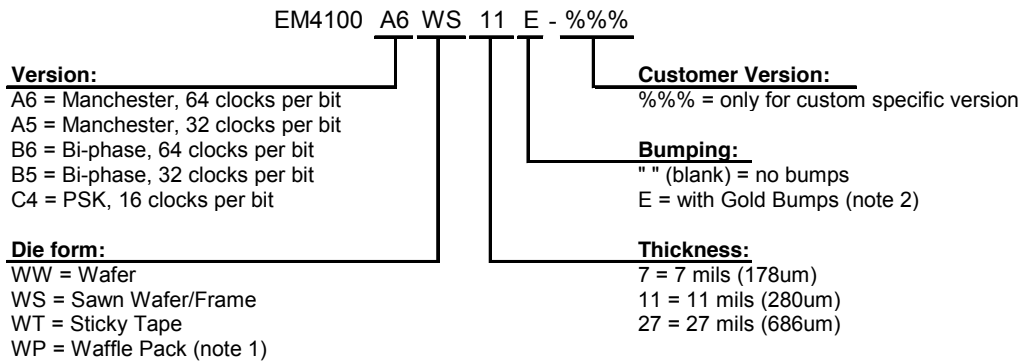
### Packaged Devices

This chart shows general offering; for detailed Part Number to order, please see the table "Standard Versions" below.



### Die Form

This chart shows general offering; for detailed Part Number to order, please see the table "Standard Versions" below.



### Remarks:

- For ordering please use table of "Standard Version" table below.
- For specifications of Delivery Form, including gold bumps, tape and bulk, as well as possible other delivery form or packages, please contact EM Microelectronic-Marin S.A.
- **Note 1:** This is a non-standard package. Please contact EM Microelectronic-Marin S.A for availability.
- **Note 2 :** Direct connection using this version is subject to license. Please contact [info@emmicroelectronic.com](mailto:info@emmicroelectronic.com)





## Standard Versions:

The versions below are considered standards and should be readily available. For other versions or other delivery form, please contact EM Microelectronic-Marín S.A. Sales Office. Please make sure to give complete part number when ordering, without spaces.

| Part Number     | Bit coding | Cycle/bit | Package/Card/Die Form              | Delivery Form / Bumping |
|-----------------|------------|-----------|------------------------------------|-------------------------|
| EM4100A5CB2RC   | Manchester | 32        | PCB Package, 2 pins                | bulk                    |
| EM4100A5CI2LC   | Manchester | 32        | CID package, 2 pins (length 2.5mm) | bulk                    |
| EM4100A6CB2RC   | Manchester | 64        | PCB Package, 2 pins                | bulk                    |
| EM4100A6CI2LB   | Manchester | 64        | CID package, 2 pins (length 2.5mm) | tape                    |
| EM4100A6CI2LC   | Manchester | 64        | CID package, 2 pins (length 2.5mm) | bulk                    |
| EM4100A6WP7     | Manchester | 64        | Die in waffle pack, 7 mils         | no bumps                |
| EM4100A6WS7     | Manchester | 64        | Sawn wafer, 7 mils                 | no bumps                |
| EM4100A6WT7     | Manchester | 64        | Die on sticky tape, 7 mils         | no bumps                |
| EM4100A6WW7     | Manchester | 64        | Unsawn wafer, 7 mils               | no bumps                |
| EM4100B5CB2RC   | Bi-phase   | 32        | PCB Package, 2 pins                | bulk                    |
| EM4100B5CI2LC   | Bi-phase   | 32        | CID package, 2 pins (length 2.5mm) | bulk                    |
| EM4100B6CB2RC   | Bi-phase   | 64        | PCB Package, 2 pins                | bulk                    |
| EM4100B6CI2LC   | Bi-phase   | 64        | CID package, 2 pins (length 2.5mm) | bulk                    |
| EM4100C4WS11    | PSK        | 16        | Sawn wafer, 11 mils thickness      | no bumps                |
| EM4100XXXXY-%%% | custom     |           | custom                             | custom                  |

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