

**ISO/IEC**  
**7816-3**



April 2009

## DESCRIPTION

The Teridian 73S8024C is a single smart card interface IC. It provides full electrical compliance with ISO-7816-3, EMV 4.0 and NDS specifications<sup>1</sup>.

Interfacing with the system controller is done through the control bus, composed of digital inputs to control the interface, and one interrupt output to inform the system controller of the card presence and faults. Data exchange with the card is managed from the system controller using the I/O line (and eventually the auxiliary I/O lines). Hardware support for auxiliary I/O lines, C4 / C8 contacts, is provided.

The card clock signal can be generated by an on-chip oscillator using an external crystal or by connection to a clock signal coming from the system controller.

The Teridian 73S8024C device incorporates an ISO-7816-3 activation/deactivation sequencer that controls the card signals. Level shifters drive the card signals with the selected card voltage (3 V or 5 V), coming from an internal DC-DC converter.

With its high-efficiency DC-DC converter, the Teridian 73S8024C is a cost-effective solution for any smart card reader application to be powered from a single 2.7 V to 3.6 V power supply.

Emergency card deactivation is initiated upon card extraction or upon any fault generated by the protection circuitry. The fault can be a  $V_{DD}$  (digital power supply) or a  $V_{CC}$  (card power supply) failure, a card over-current, or an over-heating fault.

## ADVANTAGES

- The only smart card interface IC firmware compatible with the TDA8004 operating with a single 2.7 V to 3.6 V power supply (allows removal of 5 V from the system)
- The inductor-based DC-DC converter provides higher current and efficiency than the usual charge-pump capacitor-based converters
  - Ideal for battery-powered applications
  - Suitable for high current cards and SAMs: (100 mA max)
- Power down mode: 2  $\mu$ A typical

## FEATURES

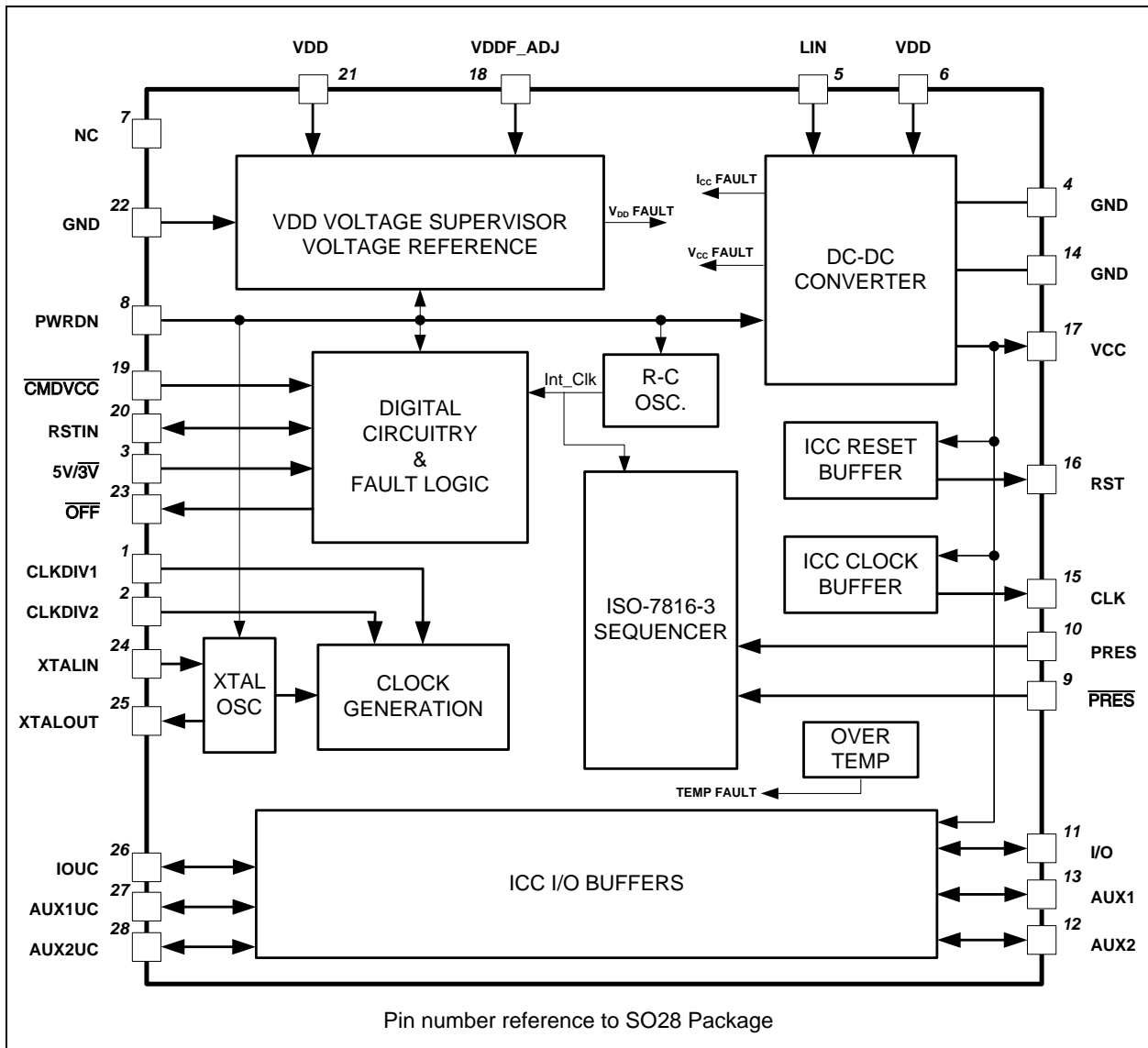
- **Card Interface:**
  - Complies with ISO-7816-3, EMV 4.0 and NDS<sup>1</sup>
  - A DC-DC Converter provides 3V / 5V to the card from an external power supply input
  - High-efficiency converter: > 80% @  $V_{DD}=3.3$  V,  $V_{CC}=5$  V and  $I_{CC} = 65$  mA
  - Up to 100 mA supplied to the card
  - ISO-7816-3 Activation / Deactivation sequencer with emergency automated deactivation on card removal or fault detected by the protection circuitry
  - Protection includes 2 voltage supervisors which detect voltage drops on card  $V_{CC}$  and on  $V_{DD}$  power supplies
  - The  $V_{DD}$  voltage supervisor threshold value can be externally adjusted
  - True over-current detection (150 mA max.)
  - 2 card detection inputs, 1 for each possible user polarity
  - Auxiliary I/O lines, for C4/C8 contact signals
  - Card clock up to 20 MHz
- **System Controller Interface:**
  - 3 Digital inputs control the card activation / deactivation, card reset and card voltage
  - 4 Digital inputs control the card clock (division rate and card clock stop modes)
  - 1 Digital output, interrupt to the system controller, allows the system controller to monitor the card presence and faults.
  - Crystal oscillator or host clock, up to 27 MHz
- **Power Supply:  $V_{DD}$  2.7 V to 3.6 V**
- **Power Down mode**
- **6 kV ESD Protection on the card interface**
- **Package: SO28**

## APPLICATIONS

- Set-Top-Boxes , DVD / HDD Recorders
- Point of Sales and Transaction Terminals
- Control Access and Identification

<sup>1</sup> Pending NDS approval.

**FUNCTIONAL DIAGRAM**



**Figure 1: 73S8024C Block Diagram**

## Table of Contents

<b>1</b>	<b>Pin Description</b> .....	<b>4</b>
1.1	Card Interface .....	4
1.2	Miscellaneous Inputs and Outputs.....	4
1.3	Power supply and ground.....	4
1.4	Microcontroller Interface .....	5
<b>2</b>	<b>System Controller Interface</b> .....	<b>6</b>
<b>3</b>	<b>Oscillator</b> .....	<b>6</b>
<b>4</b>	<b>DC-DC Converter – Card Power Supply</b> .....	<b>7</b>
<b>5</b>	<b>Over-temperature Monitor</b> .....	<b>7</b>
<b>6</b>	<b>Voltage Supervision</b> .....	<b>8</b>
<b>7</b>	<b>Power Down</b> .....	<b>8</b>
<b>8</b>	<b>Activation Sequence</b> .....	<b>9</b>
<b>9</b>	<b>Deactivation Sequence</b> .....	<b>10</b>
<b>10</b>	<b><math>\overline{\text{OFF}}</math> and Fault Detection</b> .....	<b>11</b>
<b>11</b>	<b>I/O Circuitry and Timing</b> .....	<b>12</b>
<b>12</b>	<b>Typical Application Schematic</b> .....	<b>13</b>
<b>13</b>	<b>Electrical Specification</b> .....	<b>14</b>
13.1	Absolute Maximum Ratings.....	14
13.2	Recommended Operating Conditions.....	14
13.3	Card Interface Characteristics .....	15
13.4	Digital Signals .....	18
13.5	DC Characteristics.....	18
13.6	Voltage / Temperature Fault Detection Circuits.....	18
<b>14</b>	<b>Mechanical Drawings (28-SO)</b> .....	<b>19</b>
<b>15</b>	<b>Package Pin Designation (28-SO)</b> .....	<b>20</b>
<b>16</b>	<b>Ordering Information</b> .....	<b>21</b>
<b>17</b>	<b>Related Documentation</b> .....	<b>21</b>
<b>18</b>	<b>Contact Information</b> .....	<b>21</b>
	<b>Revision History</b> .....	<b>22</b>

### Figures

Figure 1:	73S8024C Block Diagram .....	2
Figure 2:	Power Down Mode Operation.....	9
Figure 3:	Activation Sequence – RSTIN low when $\overline{\text{CMDVCC}}$ goes low .....	9
Figure 4:	Activation Sequence – RSTIN high when $\overline{\text{CMDVCC}}$ goes low .....	10
Figure 5:	Deactivation Sequence.....	11
Figure 6:	Timing Diagram – Management of the Interrupt Line $\overline{\text{OFF}}$ .....	11
Figure 7:	I/O and I/OUC State Diagram .....	12
Figure 8:	I/O – I/OUC Delays: Timing Diagram.....	12
Figure 9:	73S8024C Typical Application Schematic.....	13
Figure 10:	DC – DC Converter efficiency ( $V_{\text{CC}} = 5 \text{ V}$ ) .....	16
Figure 11:	DC – DC Converter Efficiency ( $V_{\text{CC}} = 3 \text{ V}$ ).....	16
Figure 12:	28 Lead SO.....	19

### Table

Table 1:	Choice of VCC Pin Capacitor.....	7
----------	----------------------------------	---

# 1 Pin Description

## 1.1 Card Interface

Name	Pin (SO)	Description
IO	11	Card I/O: Data signal to/from card. Includes a pull-up resistor to $V_{CC}$ .
AUX1	13	AUX1: Auxiliary data signal to/from card. Includes a pull-up resistor to $V_{CC}$ .
AUX2	12	AUX2: Auxiliary data signal to/from card. Includes a pull-up resistor to $V_{CC}$ .
RST	16	Card reset: provides reset (RST) signal to card.
CLK	15	Card clock: provides clock (CLK) signal to card. The rate of this clock is determined by crystal oscillator frequency and CLKDIV selections.
PRES	10	Card Presence switch: active high indicates card is present. Includes a pull-down current source.
$\overline{\text{PRES}}$	9	Card Presence switch: active low indicates card is present. Includes a pull-up current source.
VCC	17	Card power supply: logically controlled by the sequencer, output of DC-DC converter. Requires an external filter capacitor to the card GND.
GND	14	Card ground.

## 1.2 Miscellaneous Inputs and Outputs

Name	Pin (SO)	Description
XTALIN	24	Crystal oscillator input: can either be connected to crystal or driven as a source for the card clock.
XTALOUT	25	Crystal oscillator output: connected to crystal. Left open if XTALIN is being used as an external clock input.
VDDF_ADJ	18	$V_{DD}$ fault threshold adjustment input: this pin can be used to adjust the $V_{DDF}$ value (that controls deactivation of the card). Must be left open if unused.
NC	7	Non-connected pin.

## 1.3 Power supply and ground

Name	Pin (SO)	Description
VDD	6, 21	System controller interface supply voltage, supply voltage for internal power supply and DC-DC converter power supply source.
GND	4	DC-DC converter ground.
GND	22	Digital ground.
LIN	5	External inductor. Connect external inductor from pin 5 to $V_{DD}$ . Keep the inductor close to pin 5.

## 1.4 Microcontroller Interface

Name	Pin (SO)	Description															
CMDVCC	19	Command $V_{CC}$ (negative assertion): Logic low on this pin causes the DC-DC converter to ramp the $V_{CC}$ supply to the card and initiates a card activation sequence.															
5V/3V	3	5 volt / 3 volt card selection: Logic one selects 5 volts for $V_{CC}$ and card interface, logic low selects 3 volt operation. When the part is to be used with a single card voltage, this pin should be tied to either GND or $V_{DD}$ . However, it includes a high impedance pull-up resistor to default this pin high (selection of 5 V card) when unconnected.															
PWRDN	8	Power Down control input (active high): When Power Down (PD) mode is activated; all internal analog functions are disabled to place the 73S8024C in its lowest power consumption mode. The PD mode is allowed only out of a card session (= PWRDN high is not taken into account when CMDVCC = 0). Must be tied to ground when the power down function is not used.															
CLKDIV1 CLKDIV2	1 2	Sets the divide ratio from the XTALIN oscillator (or external clock input) to the card clock. These pins include pull-down resistors. <table border="1" data-bbox="646 751 1222 968"> <thead> <tr> <th>CLKDIV1</th> <th>CLKDIV2</th> <th>Clock Rate</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>XTALIN/8</td> </tr> <tr> <td>0</td> <td>1</td> <td>XTALIN/4</td> </tr> <tr> <td>1</td> <td>1</td> <td>XTALIN/2</td> </tr> <tr> <td>1</td> <td>0</td> <td>XTALIN</td> </tr> </tbody> </table>	CLKDIV1	CLKDIV2	Clock Rate	0	0	XTALIN/8	0	1	XTALIN/4	1	1	XTALIN/2	1	0	XTALIN
CLKDIV1	CLKDIV2	Clock Rate															
0	0	XTALIN/8															
0	1	XTALIN/4															
1	1	XTALIN/2															
1	0	XTALIN															
OFF	23	Interrupt signal to the processor (active low): Multi-function indicating fault conditions and card presence. Open drain output configuration; it includes an internal 20 k $\Omega$ pull-up to $V_{DD}$ .															
RSTIN	20	Reset Input: This signal is the reset command to the card.															
I/OUC	26	System controller data I/O to/from the card. Includes internal pull-up resistor to $V_{DD}$ .															
AUX1UC	27	System controller auxiliary data I/O to/from the card. Includes internal pull-up resistor to $V_{DD}$ .															
AUX2UC	28	System controller auxiliary data I/O to/from the card. Includes internal pull-up resistor to $V_{DD}$ .															

## 2 System Controller Interface

- 2 digital inputs allow direct control of the card interface from the host as follows:
  - Pin  $\overline{\text{CMDVCC}}$ : When low, starts an activation sequence if a card is present.
  - Pin  $5\text{V}/\overline{3\text{V}}$ : Defines the card voltage.
- The card I/O and Reset signals have their corresponding controller I/Os to be connected directly to the host:
  - Pin RSTIN: controls the card reset signal (when enabled by the sequencer).
  - Pin I/OUC: data transfer to card I/O contact.
  - Pins AUX1UC and AUX2UC (auxiliary I/O lines associated to the auxiliary I/O lines to be connected to the C4 and C8 card connector contacts).
- 2 digital inputs control the card clock frequency division rate: CLKDIV1 and CLKDIV2 define the card clock frequency, from the input clock frequency (crystal or external clock). The division rate is defined as follows:

CLKDIV2	CLKDIV1	CLK
0	0	$\frac{1}{8}$ XTAL
0	1	XTAL
1	0	$\frac{1}{4}$ XTAL
1	1	$\frac{1}{2}$ XTAL



When the division rate is equal to 1 (CLKDIV2 = 0 and CLKDIV1 = 1), the duty-cycle of the card clock depends on the duty-cycle and waveform of the signal applied on the pin XTALIN. When other division rates are used, the 73S8024C circuitry guarantees a duty-cycle in the range 45% to 55%, conforming to ISO-7816-3, EMV 4.0 and NDS specifications.

- Interrupt output to the host: As long as the card is not activated, the  $\overline{\text{OFF}}$  pin informs the host about the card presence only (low = no card in the reader). When  $\overline{\text{CMDVCC}}$  is set low (Card activation sequence requested from the host), a low level on  $\overline{\text{OFF}}$  means a fault has been detected (e.g. card removed during a card session, or voltage fault, or thermal / over-current fault) that automatically initiates a deactivation sequence.
- Power Down: The PWRDN pin is a digital input that allows the host controller to put the 73S8024C in its Power Down state. This pin can only be activated out of a card session.

## 3 Oscillator

The 73S8024C device has an on-chip oscillator that can generate the smart card clock using an external crystal (connected between the pins XTALIN and XTALOUT) to set the oscillator frequency. When the card clock signal is available from another source, it can be connected to the pin XTALIN, and the pin XTALOUT should be left unconnected.

## 4 DC-DC Converter – Card Power Supply

An internal DC-DC converter provides the card power supply. This converter is able to provide either 3 V or 5 V card voltage from the power supply applied on the  $V_{DD}$  pin. The digital ISO-7816-3 sequencer controls the converter. Card voltage selection is carried out by the digital input  $5V/3V$ .

The circuit is an inductive step-up converter/regulator. The external components required are 2 filter capacitors on the power-supply input  $V_{DD}$  (next to the LIN pin, 100 nF + 10  $\mu$ F), an inductor, and an output filter capacitor on the card power supply  $V_{CC}$ . The circuit performs regulation by activating the step-up operation when  $V_{CC}$  is below a set point of 5.0 or 3.0 volts minus a comparator hysteresis voltage and the input supply  $V_{DD}$  is less than the set point for  $V_{CC}$ . When  $V_{DD}$  is greater than the set point for  $V_{CC}$  ( $V_{DD} = 3.6$  V,  $V_{CC} = 3$  V) the circuit operates as a linear regulator.

Depending on the inductor values, the voltage converter can provide current on  $V_{CC}$  as high as 100 mA. The circuit provides over-current protection and limits  $I_{CC}$  to 150 mA. When an over-current condition is sensed, the circuit initiates a deactivation sequence from the control logic and reports back to the host controller a fault on the interrupt output OFF.

### Choice of the inductor

The nominal inductor value is 10  $\mu$ H, rated for 400 mA. The inductor is connected between LIN (pin 5 in the SO package, pin 2 in the QFN package) and the  $V_{DD}$  voltage. The inductor value can be optimized to meet a particular configuration ( $I_{CC\_MAX}$ ). The inductor should be located on the PCB as close as possible to the LIN pin of the IC.

### Choice of the $V_{CC}$ capacitor

Depending on the applications, the requirements in terms of both the  $V_{CC}$  minimum voltage and the transient currents that the interface must provide to the card are different. [Table 1](#) shows the recommended capacitors for each  $V_{CC}$  power supply configuration and applicable specification.

**Table 1: Choice of VCC Pin Capacitor**

Specification Requirement			Application	
Specification	Min $V_{CC}$ Voltage Allowed During Transient Current	Max Transient Current Charge	Capacitor Type	Capacitor Value
EMV 4.0	4.6 V	30 nAs	X5R/X7R w/ ESR < 100 m $\Omega$	3.3 $\mu$ F
ISO-7816-3	4.5 V	20 nAs		1 $\mu$ F

**Table 1: Choice of VCC Pin Capacitor**

## 5 Over-temperature Monitor

A built-in detector monitors die temperature. When an over-temperature condition occurs, a card deactivation sequence is initiated, and an error or fault condition is reported to the system controller.

## 6 Voltage Supervision

Two voltage supervisors constantly check the level of the voltages  $V_{DD}$  and  $V_{CC}$ . A card deactivation sequence is triggered upon a fault of any of these voltage supervisors.

The digital circuitry is powered by the power supply applied on the VDD pin.  $V_{DD}$  also defines the voltage range for the interface with the system controller. The  $V_{DD}$  Voltage supervisor is also used to initialize the ISO-7816-3 sequencer at power-on, and also to deactivate the card at power-off or upon a fault. The voltage threshold of the  $V_{DD}$  voltage supervisor is internally set by default to 2.3 V nominal. However, it may be desirable, in some applications, to modify this threshold value. The pin VDDF\_ADJ (pin 18 in the SO package, pin 17 in the QFN package) is used to connect an external resistor  $R_{EXT}$  to ground to raise the  $V_{DD}$  fault voltage to another value,  $V_{DDF}$ . The resistor value is defined as follows:

$$R_{EXT} = 180 \text{ k}\Omega / (V_{DDF} - 2.33)$$

An alternative (more accurate) method of adjusting the  $V_{DD}$  fault voltage is to use a resistive network of R3 from the pin to supply and R1 from the pin to ground (see [Figure 9](#)). In order to set the new threshold voltage, the equivalent resistance must be determined. This resistance value will be designated Kx. Kx is defined as  $R1/(R1+R3)$  and is calculated as:

$$Kx = (2.649 / V_{TH}) - 0.6042 \text{ where } V_{TH} \text{ is the desired new threshold voltage.}$$

To determine the values of R1 and R3, use the following formulas:

$$R3 = 72000 / Kx \quad R1 = R3 * (Kx / (1 - Kx))$$

Taking the example above, where a  $V_{DD}$  fault threshold voltage of 2.7 V is desired, solving for Kx gives:

$$\rightarrow Kx = (2.649 / 2.7) - 0.6042 = 0.377.$$

Solving for R3 gives:  $\rightarrow R3 = 72000 / 0.377 = 191 \text{ k}\Omega$ .

Solving for R1 gives:  $\rightarrow R1 = 191000 * (0.377 / (1 - 0.377)) = 115.6 \text{ k}\Omega$ .

Using standard 1% resistor values gives  $R3 = 191 \text{ k}\Omega$  and  $R1 = 115 \text{ k}\Omega$ . These values give an equivalent resistance of  $Kx = 0.376$ , a 0.3% error.

If the 2.3 V default threshold is used, this pin must be left unconnected.

## 7 Power Down

A power down function is provided via the PWRDN pin (active high). When activated, the Power Down (PD) mode disables all the internal analog functions, including the card analog interface, the oscillators and the DC-DC converter, to put the 73S8024C in its lowest power consumption mode. PD mode is only allowed in the deactivated condition (out of a card session, when the  $\overline{CMDVCC}$  signal is driven high from the host controller).

The host controller invokes the power down state when it is desirable to save power. The signals  $\overline{PRES}$  and  $\overline{PRES}$  remain functional in PD mode such that a card insertion sets  $\overline{OFF}$  high. The micro-controller must then set PWRDN low and wait for the internal stabilization time prior to starting any card session (prior to turning  $\overline{CMDVCC}$  low).

Resumption of the normal mode occurs at approximately 10 ms (stabilization of the internal oscillators and reset of the circuitry) after PWRDN is set low. No card activation should be invoked during this 10 ms time period. If a card is present,  $\overline{OFF}$  can be used as an indication that the circuit has completed its recovery from the power down state.  $\overline{OFF}$  will go high at the end of the stabilization period. Should  $\overline{CMDVCC}$  go low during PWRDN = 1, or within the 10 ms internal stabilization / reset time, it will not be taken into account and the card interface will remain inactive. Since  $\overline{CMDVCC}$  is taken into account on its edges, it should be toggled high and low again after the 10 ms to activate a card.

[Figure 2](#) illustrates the sequencing of the PD and Normal modes. PWRDN must be connected to GND if the power down function is not used.



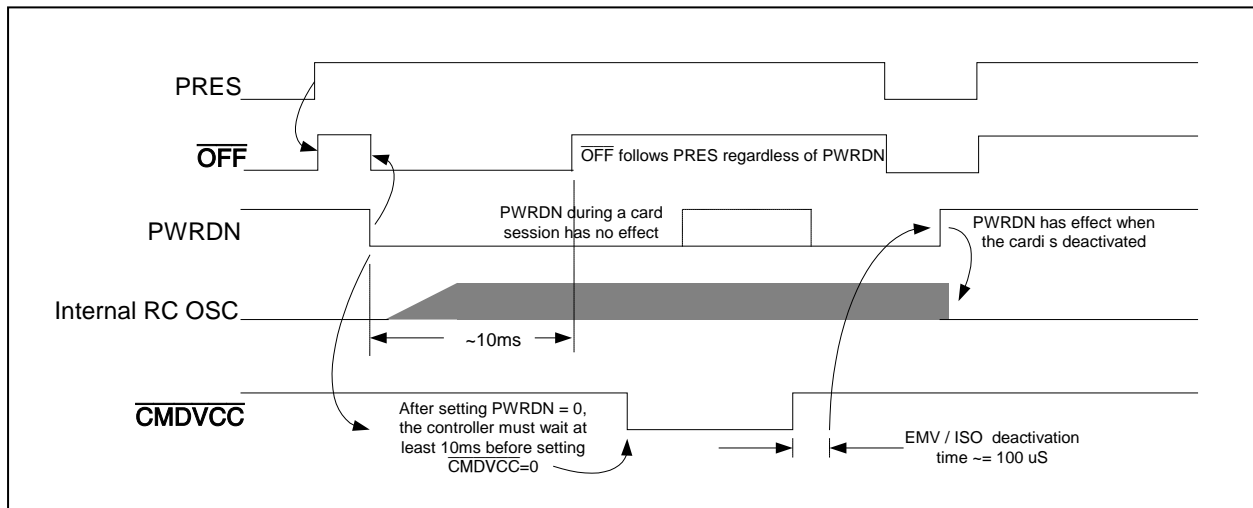


Figure 2: Power Down Mode Operation

## 8 Activation Sequence

The 73S8024C smart card interface IC has an internal 10 ms delay at power-on reset or upon application of  $V_{DD} > V_{DDF}$  or upon exit of Power-Down mode. The card interface may only be activated when  $\overline{\text{OFF}}$  is high which indicates a card is present. No activation is allowed at this time.  $\overline{\text{CMDVCC}}$  (edge triggered) must then be set low to activate the card.

The following steps and Figure 3 show the activation sequence and the timing of the card control signals when the system controller sets  $\overline{\text{CMDVCC}}$  low while the RSTIN is low:

1.  $\overline{\text{CMDVCC}}$  is set low.
2. Next, the internal  $V_{CC}$  control circuit checks the presence of  $V_{CC}$  at the end of  $t_1$ . In normal operation, the voltage  $V_{CC}$  to the card becomes valid during  $t_1$ . If  $V_{CC}$  does not become valid, then  $\overline{\text{OFF}}$  goes low to report a fault to the system controller, and the power  $V_{CC}$  to the card is shut down.
3. Turn I/O (AUX1, AUX2) to reception mode at the end of  $t_2$ .
4. Due to the fall of RSTIN, CLK is applied to the card at the end of  $t_3$ .
5. RST is a copy of RSTIN after  $t_4$ . RSTIN may be set high before  $t_4$ , however the sequencer won't set RST high until 42000 clock cycles after the start of CLK.

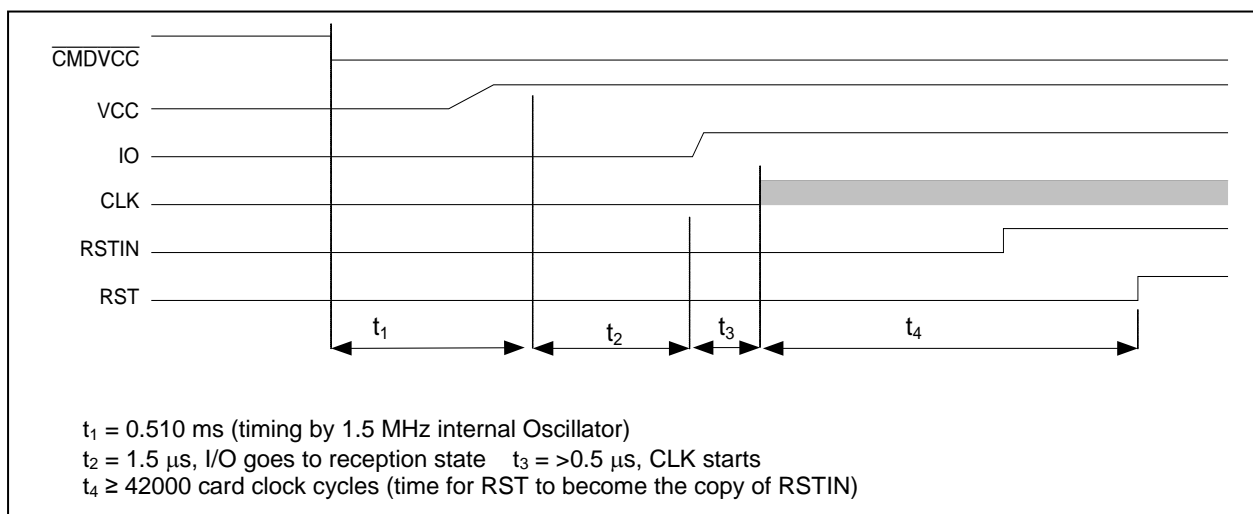
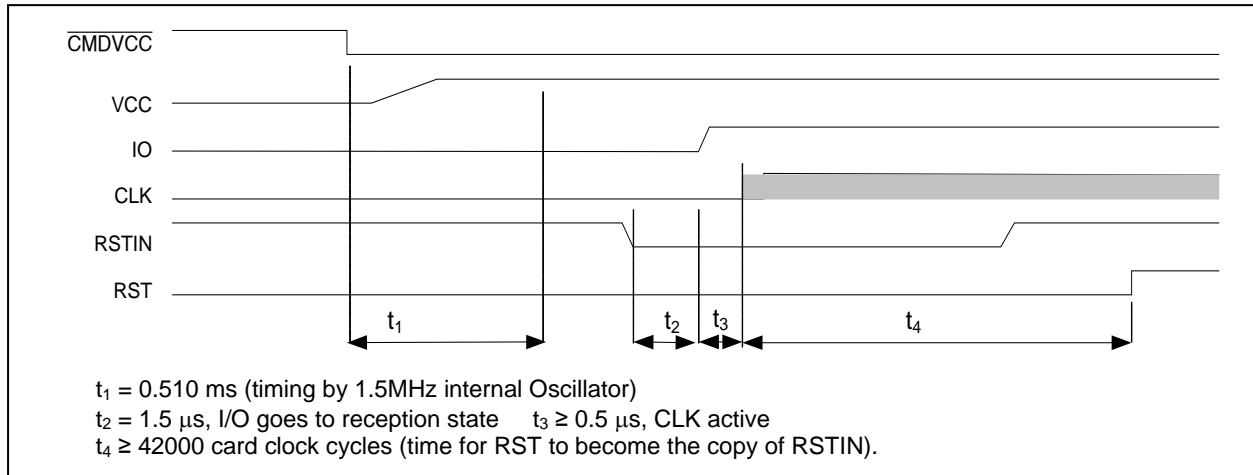


Figure 3: Activation Sequence – RSTIN low when  $\overline{\text{CMDVCC}}$  goes low

The following steps and [Figure 4](#) show the activation sequence and the timing of the card control signals when the system controller pulls  $\overline{\text{CMDVCC}}$  low while RSTIN is high:

1.  $\overline{\text{CMDVCC}}$  is set low.
2. Next, the internal  $V_{\text{CC}}$  control circuit checks the presence of  $V_{\text{CC}}$  at the end of  $t_1$ . In normal operation, the voltage  $V_{\text{CC}}$  to the card becomes valid during this time. If not,  $\overline{\text{OFF}}$  goes low to report a fault to the system controller and the  $V_{\text{CC}}$  power to the card is shut down.
3. After the fall of RSTIN at  $t_2$ , turn I/O (AUX1, AUX2) to reception mode.
4. CLK is applied to the card at the end of  $t_3$  after I/O is in reception mode.
5. RST is a copy of RSTIN after  $t_4$ . RSTIN may be set high before  $t_4$ , however the sequencer will not set RST high until 42,000 clock cycles after the start of CLK.



**Figure 4: Activation Sequence – RSTIN high when  $\overline{\text{CMDVCC}}$  goes low**

## 9 Deactivation Sequence

Deactivation is initiated either by the system controller by setting the  $\overline{\text{CMDVCC}}$  high, or automatically in the event of hardware faults. Hardware faults are over-current, overheating,  $V_{\text{DD}}$  fault,  $V_{\text{CC}}$  fault, and card extraction during the session.

The following steps and [Figure 5](#) show the deactivation sequence and the timing of the card control signals when the system controller sets the  $\overline{\text{CMDVCC}}$  high or  $\overline{\text{OFF}}$  goes low due to a fault or card removal:

1. RST goes low at the end of time  $t_1$ .
2. CLK is set low at the end of time  $t_2$ .
3. I/O goes low at the end of time  $t_3$ . Out of reception mode.
4.  $V_{\text{CC}}$  is turned off at the end of time  $t_4$ . After a delay  $t_5$  (discharge of the  $V_{\text{CC}}$  capacitor),  $V_{\text{CC}}$  is low.

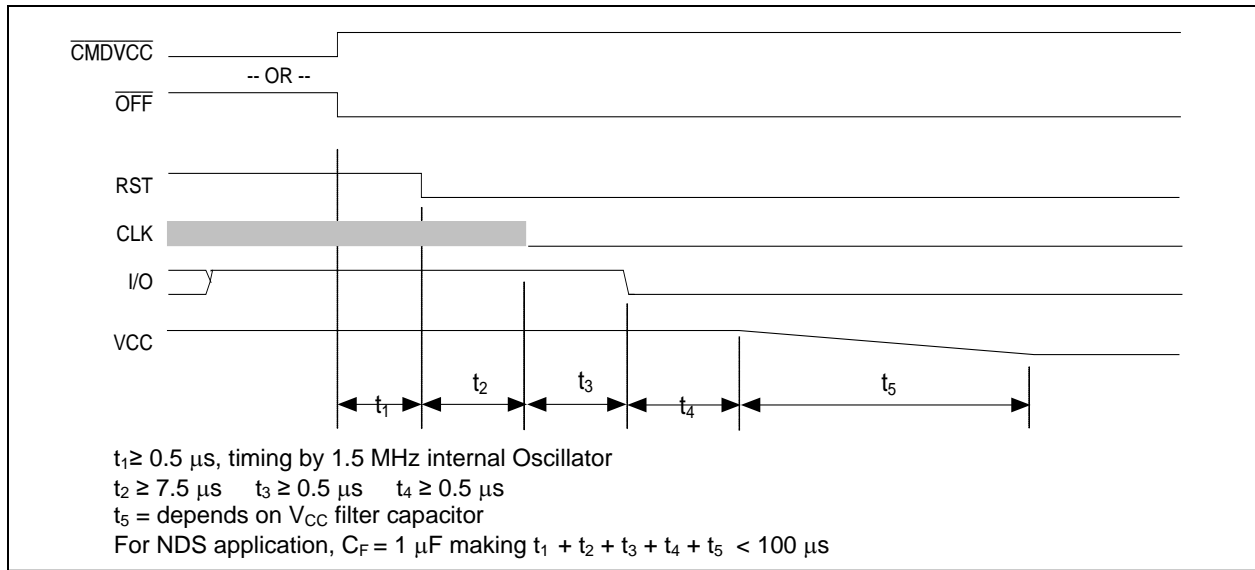


Figure 5: Deactivation Sequence

## 10 $\overline{\text{OFF}}$ and Fault Detection

There are two cases for which the system controller can monitor the  $\overline{\text{OFF}}$  signal: to query regarding the card presence outside card sessions, or for fault detection during card sessions.

### Monitoring Outside a Card Session

In this condition,  $\overline{\text{CMDVCC}}$  is always high,  $\overline{\text{OFF}}$  is low if the card is not present, and high if the card is present. Because it is outside a card session, any fault detection will not act upon the  $\overline{\text{OFF}}$  signal. No deactivation is required during this time.

### Monitoring During a Card Session

$\overline{\text{CMDVCC}}$  is always low, and  $\overline{\text{OFF}}$  falls low if the card is extracted or if any fault is detected. At the same time that  $\overline{\text{OFF}}$  is set low, the sequencer starts the deactivation process.

Figure 6 shows the timing diagram for the  $\overline{\text{CMDVCC}}$ ,  $\overline{\text{PRES}}$ , and  $\overline{\text{OFF}}$  signals during a card session and outside the card session.

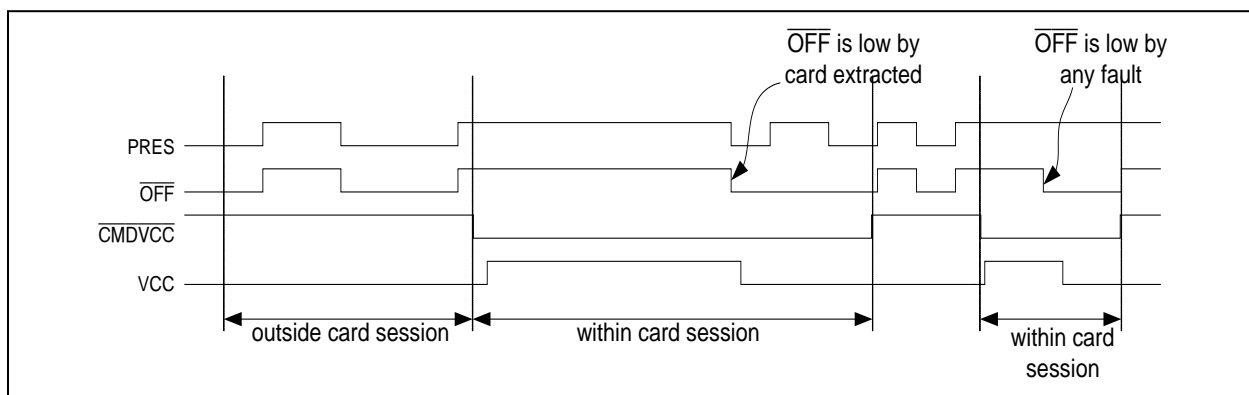


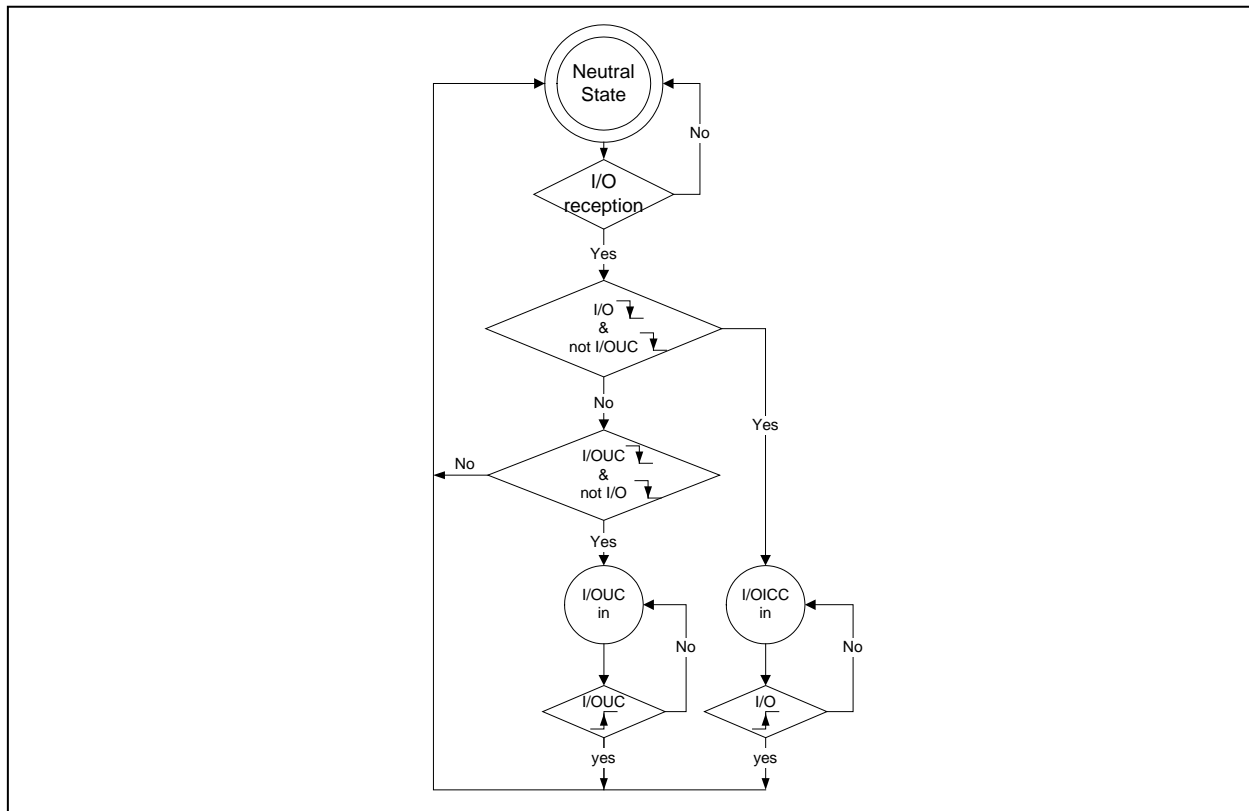
Figure 6: Timing Diagram – Management of the Interrupt Line  $\overline{\text{OFF}}$

## 11 I/O Circuitry and Timing

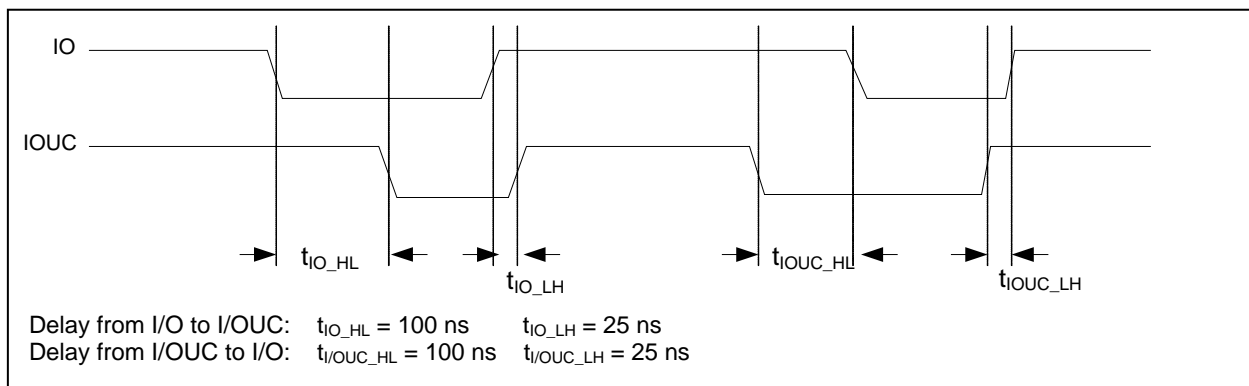
The I/O, AUX1, and AUX2 pins are in the low state after power on reset and they are in the high state when the activation sequencer turns on the I/O reception state. See [Section 8 Activation Sequence](#) for more details on when the I/O reception is on.

The state of the I/OUC, AUX1UC, and AUX2UC is high after power on reset. Within a card session and when the I/O reception state is on, the first I/O line on which a falling edge is detected becomes the input I/O line and the other becomes the output I/O line. When the input I/O line rising edge is detected, both I/O lines return to their neutral state.

[Figure 7](#) shows the state diagram of how the I/O and I/OUC lines are managed to become input or output. The delay between the I/O signals is shown in [Figure 8](#).

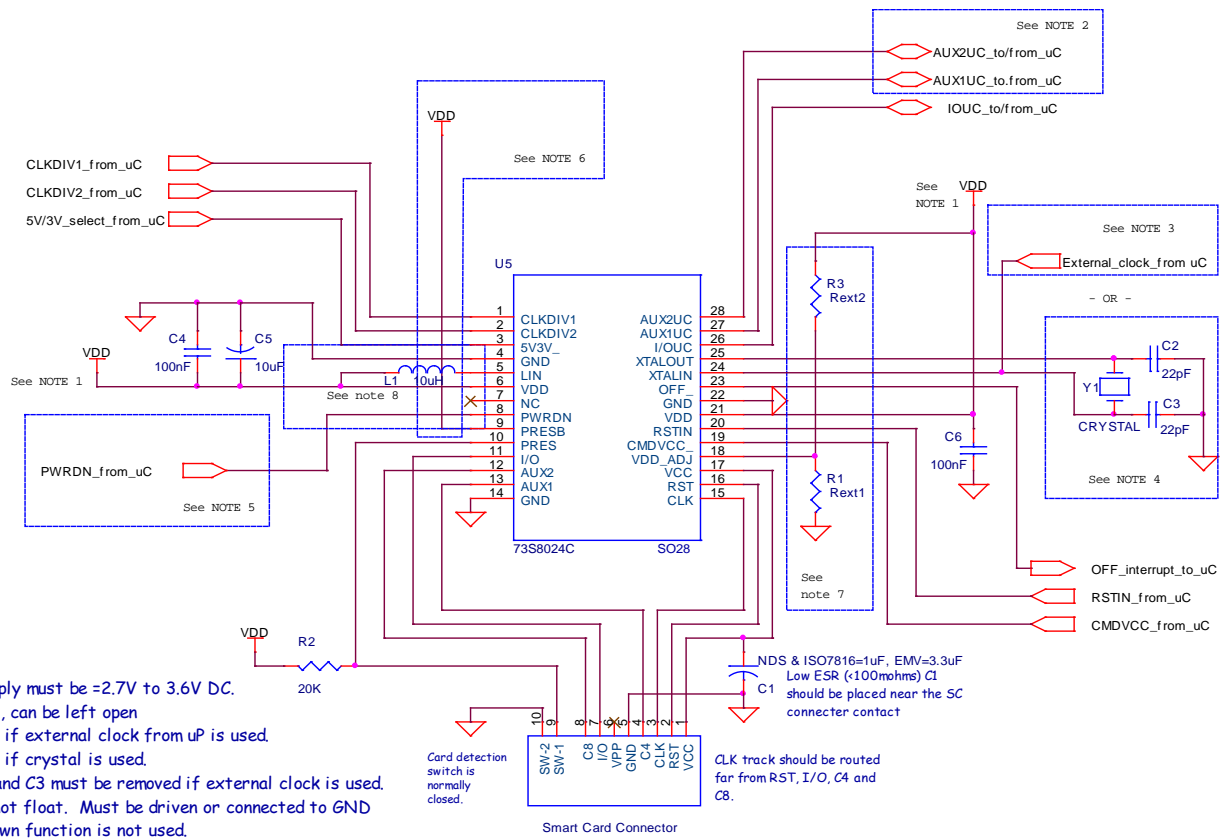


**Figure 7: I/O and I/OUC State Diagram**



**Figure 8: I/O – I/OUC Delays: Timing Diagram**

### 12 Typical Application Schematic



**NOTES:**

- 1) VDD supply must be =2.7V to 3.6V DC.
- 2) Optional, can be left open
- 3) Required if external clock from uP is used.
- 4) Required if crystal is used.  
Y1, C2 and C3 must be removed if external clock is used.
- 5) Pin can not float. Must be driven or connected to GND if power down function is not used.
- 6) Internal pull-up allows it to be left open if unused.
- 7) Rext1 and Rext2 are external resistors to ground and Vdd to modify the VDDfault voltage. Can be left open
- 8) Keep L1 close to pin 5

**Figure 9: 73S8024C Typical Application Schematic**

## 13 Electrical Specification

### 13.1 Absolute Maximum Ratings



Operation outside these rating limits may cause permanent damage to the device.

Parameter	Rating
Supply Voltage $V_{DD}$	-0.5 to 4.0 VDC
Input Voltage for Digital Inputs	-0.3 to ( $V_{DD} + 0.5$ ) VDC
Storage Temperature	-60 °C to 150 °C
Pin Voltage (except LIN and card interface)	-0.3 to ( $V_{DD} + 0.5$ ) VDC
Pin Voltage (LIN)	-0.3 to 6.0 VDC
Pin Voltage (card interface)	-0.3 to ( $V_{CC} + 0.5$ ) VDC
ESD Tolerance – Card interface pins	+/- 6 kV
ESD Tolerance – Other pins	+/- 2 kV



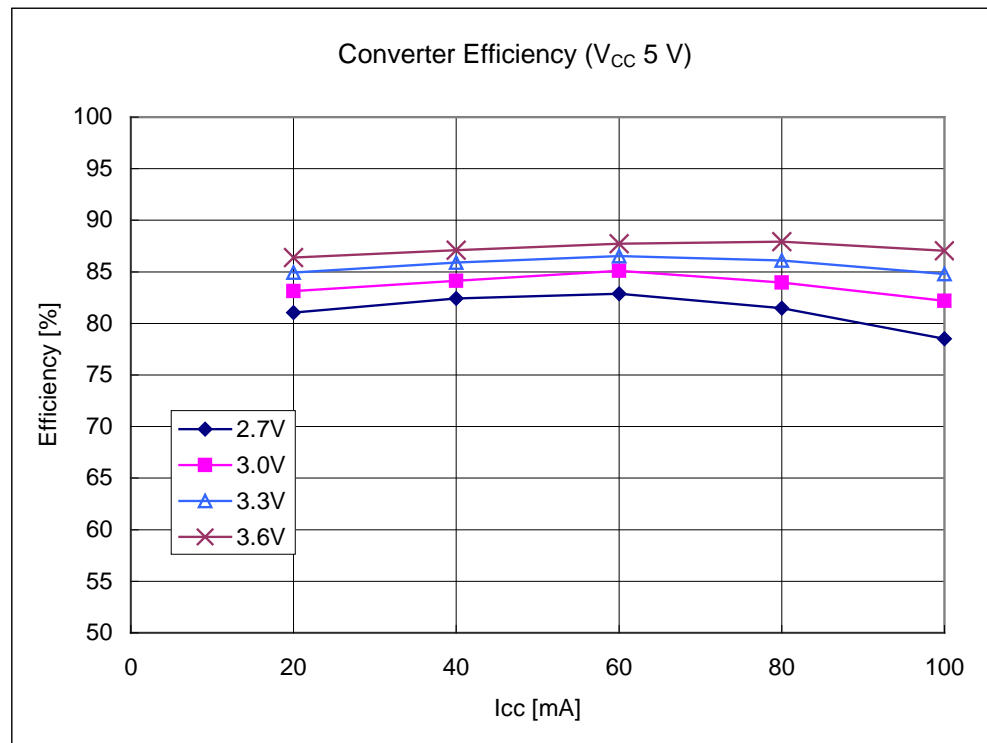
ESD testing on Card pins uses the HBM condition, 3 pulses, each polarity referenced to ground.

### 13.2 Recommended Operating Conditions

Parameter	Rating
Supply Voltage $V_{DD}$	2.7 to 3.6 VDC
Ambient Operating Temperature	-40 °C to +85 °C
Input Voltage for Digital Inputs	0 V to $V_{DD} + 0.3$ V

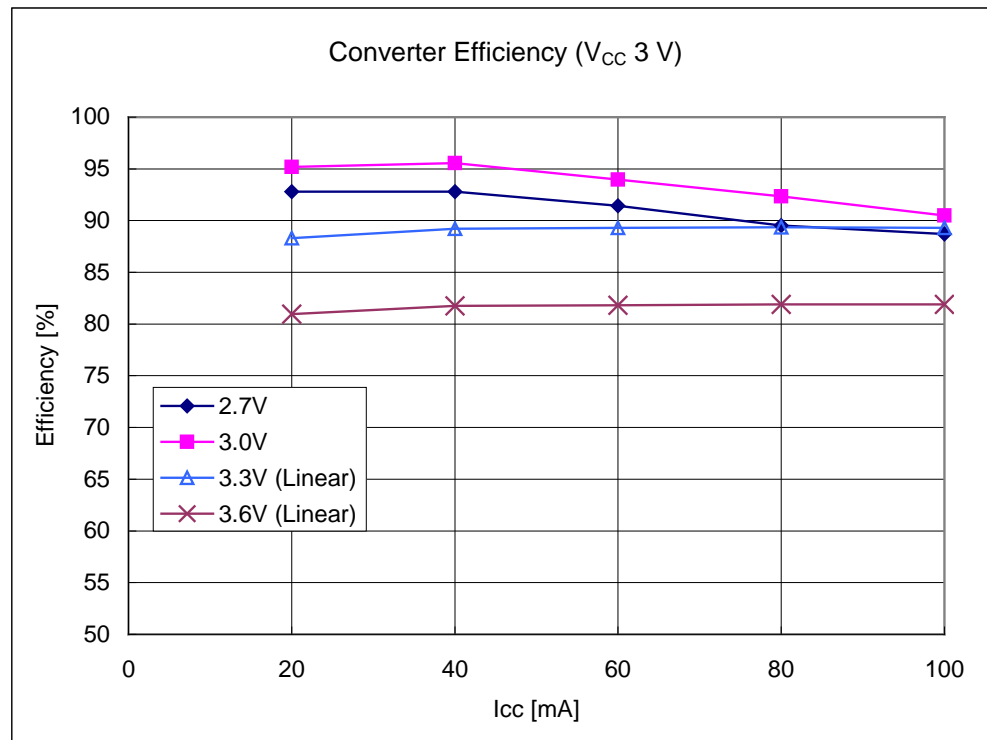
### 13.3 Card Interface Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
<b>Card Power Supply (<math>V_{CC}</math>) DC-DC Converter</b>						
<b>General conditions, <math>-40\text{ }^{\circ}\text{C} &lt; T &lt; 85\text{ }^{\circ}\text{C}</math>, <math>2.7\text{ V} &lt; V_{DD} &lt; 3.6\text{ V}</math></b>						
$V_{CC}$	Card supply voltage including ripple and noise	Inactive mode	-0.1		0.1	V
		Inactive mode $I_{CC} = 1\text{ mA}$	-0.1		0.4	V
		Active mode $I_{CC} < 65\text{ mA}$ ; $5\text{ V}$	4.75		5.25	V
		Active mode $I_{CC} < 65\text{ mA}$ ; $3\text{ V}$	2.8		3.2	V
		Active mode single pulse of $100\text{ mA}$ for $2\text{ }\mu\text{s}$ ; $5\text{ V}$ , fixed load = $25\text{ mA}$	4.6		5.25	V
		Active mode single pulse of $100\text{ mA}$ for $2\text{ }\mu\text{s}$ ; $3\text{ V}$ , fixed load = $25\text{ mA}$	2.76		3.2	V
		Active mode current pulses of $40\text{ nAs}$ with peak $ I_{CC}  < 200\text{ mA}$ , $t < 400\text{ ns}$ ; $5\text{ V}$	4.6		5.25	V
		Active mode current pulses of $40\text{ nAs}$ with peak $ I_{CC}  < 200\text{ mA}$ , $t < 400\text{ ns}$ ; $3\text{ V}$	2.76		3.2	V
$I_{CCmax}$	Maximum supply current to the card	Static load current, $V_{CC} > 4.6$ or $2.7$ volts as selected, $L=10\text{ }\mu\text{H}$	100			mA
$I_{CCF}$	$I_{CC}$ fault current		100	125	180	mA
$V_{SR}$	$V_{CC}$ slew rate – Rise rate on activate	$C_F$ on $V_{CC} = 1\text{ }\mu\text{F}$	0.05	0.15	0.25	V/ $\mu\text{s}$
$V_{SF}$	$V_{CC}$ slew rate – Fall rate on deactivate	$C_F$ on $V_{CC} = 1\text{ }\mu\text{F}$	0.1	0.3	0.5	V/ $\mu\text{s}$
$C_F$	External filter capacitor ( $V_{CC}$ to GND)		0.47	1	3.3	$\mu\text{F}$
L	Inductor (LIN to $V_{DD}$ )			10		$\mu\text{H}$
L <sub>imax</sub>	L <sub>imax</sub> in inductor	$V_{CC} = 5\text{ V}$ , $I_{CC} = 65\text{ mA}$ , $V_{DD} = 2.7\text{ V}$			400	mA
$\eta$	Efficiency	$V_{CC} = 5\text{ V}$ , $I_{CC} = 65\text{ mA}$ , $V_{DD} = 3.3\text{ V}$		80		%



**Figure 10: DC – DC Converter efficiency ( $V_{CC} = 5$  V)**

Output current on  $V_{CC}$  at 5 V. Input voltage on  $V_{DD}$  at 2.7, 3.0, 3.3 and 3.6 volts.



**Figure 11: DC – DC Converter Efficiency ( $V_{CC} = 3$  V)**

Output current on  $V_{CC}$  at 3 V. Input voltage on  $V_{DD}$  at 2.7, 3.0, 3.3 and 3.6 volts.



Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
<b>Interface Requirements – Data Signals: I/O, AUX1, AUX2, and host interfaces: I/OUC, AUX1UC, AUX2UC.</b> $I_{SHORTL}$ , $I_{SHORTH}$ , and $V_{INACT}$ requirements do not pertain to I/OUC, AUX1UC, and AUX2UC. $I_{IL}$ requirements only pertain to I/OUC, AUX1UC, and AUX2UC.						
$V_{OH}$	Output level, high (I/O, AUX1, AUX2)	$I_{OH} = 0$	$0.9 V_{CC}$		$V_{CC} + 0.1$	V
		$I_{OH} = -40 \mu A$	$0.75 V_{CC}$		$V_{CC} + 0.1$	V
$V_{OH}$	Output level, high (I/OUC, AUX1UC, AUX2UC)	$I_{OH} = 0$	$0.9 V_{DD}$		$V_{DD} + 0.1$	V
		$I_{OH} = -40 \mu A$	$0.75 V_{DD}$		$V_{DD} + 0.1$	V
$V_{OL}$	Output level, low	$I_{OL} = 1 \text{ mA}$			0.3	V
$V_{IH}$	Input level, high (I/O, AUX1, AUX2)		1.8		$V_{CC} + 0.30$	V
$V_{IH}$	Input level, high (I/OUC, AUX1UC, AUX2UC)		1.8		$V_{DD} + 0.30$	V
$V_{IL}$	Input level, low		-0.3		0.8	V
$V_{INACT}$	Output voltage when outside of session	$I_{OL} = 0$			0.1	V
		$I_{OL} = 1 \text{ mA}$			0.3	V
$I_{LEAK}$	Input leakage	$V_{IH} = V_{CC}$			10	$\mu A$
$I_{IL}$	Input current, low	$V_{IL} = 0, CS = 1$			0.65	mA
		$V_{IL} = 0, CS = 0$			5	$\mu A$
$I_{SHORTL}$	Short circuit output current	For output low, shorted to $V_{CC}$ through $33 \Omega$			15	mA
$I_{SHORTH}$	Short circuit output current	For output high, shorted to ground through $33 \Omega$			15	mA
$t_R, t_F$	Output rise time, fall times	$C_L = 80 \text{ pF}$ , 10% to 90%. For I/OUC, AUX1UC, AUX2UC, $C_L = 50 \text{ pF}$			100	ns
$t_{IR}, t_{IF}$	Input rise, fall times				1	$\mu s$
$R_{PU}$	Internal pull-up resistor	Output stable for > 200ns	8	11	14	k $\Omega$
$FD_{MAX}$	Maximum data rate				1	MHz
$T_{FDIO}$	Delay, I/O to I/OUC, I/OUC to I/O (falling edge to falling edge)			100		ns
$C_{IN}$	Input capacitance				10	pF
<b>Reset and Clock for card interface, RST, CLK</b>						
$V_{OH}$	Output level, high	$I_{OH} = -200 \mu A$	$0.9 V_{CC}$		$V_{CC}$	V
$V_{OL}$	Output level, low	$I_{OL} = 200 \mu A$	0		0.3	V
$V_{INACT}$	Output voltage when outside of a session	$I_{OL} = 0$			0.1	V
		$I_{OL} = 1 \text{ mA}$			0.3	V
$I_{RST\_LIM}$	Output current limit, RST				30	mA
$I_{CLK\_LIM}$	Output current limit, CLK				70	mA
$t_R, t_F$	Output rise time, fall time	$C_L = 35 \text{ pF}$ for CLK, 10% to 90%			8	ns
		$C_L = 200 \text{ pF}$ for RST, 10% to 90%			100	ns
$\delta$	Duty cycle for CLK, except for $f = f_{XTAL}$	$C_L = 35 \text{ pF}$ , $F_{CLK} \leq 20 \text{ MHz}$	45		55	%

### 13.4 Digital Signals

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
<b>Digital I/O except for OSC I/O</b>						
V <sub>IL</sub>	Input Low Voltage		-0.3		0.8	V
V <sub>IH</sub>	Input High Voltage		1.8		V <sub>DD</sub> + 0.3	V
V <sub>OL</sub>	Output Low Voltage	I <sub>OL</sub> = 2 mA			0.45	V
V <sub>OH</sub>	Output High Voltage	I <sub>OH</sub> = -1 mA	V <sub>DD</sub> - 0.45			V
ROUT	Pull-up resistor, OFF			20		kΩ
I <sub>IL1</sub>	Input Leakage Current	GND < V <sub>IN</sub> < V <sub>DD</sub>	-5		5	μA
<b>Oscillator (XTALIN) I/O Parameters</b>						
V <sub>ILXTAL</sub>	Input Low Voltage - XTALIN		-0.3		0.3 V <sub>DD</sub>	V
V <sub>IHXTAL</sub>	Input High Voltage - XTALIN		0.7 V <sub>DD</sub>		V <sub>DD</sub> + 0.3	V
I <sub>ILXTAL</sub>	Input Current - XTALIN	GND < V <sub>IN</sub> < V <sub>DD</sub>	-30		30	μA
f <sub>MAX</sub>	Max freq. Osc or external clock				27	MHz
δ <sub>in</sub>	External input duty cycle limit	t <sub>r/f</sub> < 10% f <sub>IN</sub> , 45% < δ <sub>CLK</sub> < 55%	48		52	%

### 13.5 DC Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I <sub>PC</sub>	Supply Current on V <sub>DD</sub>	Linear mode, I <sub>CC</sub> = 0 I/O, AUX1, AUX2 = high		4.9		mA
		Step up mode, I <sub>CC</sub> = 0 I/O, AUX1, AUX2 = high		4.7		mA
I <sub>DD_PD</sub>	Supply Current on V <sub>DD</sub> in Power Down mode	PWRDN=1, Start/stop bit = 0 All digital inputs driven with a true logical 0 or 1		0.11	2.5	μA

### 13.6 Voltage / Temperature Fault Detection Circuits

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V <sub>DDF</sub>	V <sub>DD</sub> fault (V <sub>DD</sub> Voltage supervisor threshold)	No external resistor on VDDF_ADJ	2.15		2.4	V
V <sub>CCF</sub>	V <sub>CC</sub> fault (V <sub>CC</sub> Voltage supervisor threshold)	V <sub>CC</sub> = 5 V	4.20		4.6	V
		V <sub>CC</sub> = 3 V	2.5		2.7	V
T <sub>F</sub>	Die over temperature fault		115		145	°C
I <sub>CCF</sub>	Card over current fault		90		150	mA

### 14 Mechanical Drawings (28-SO)

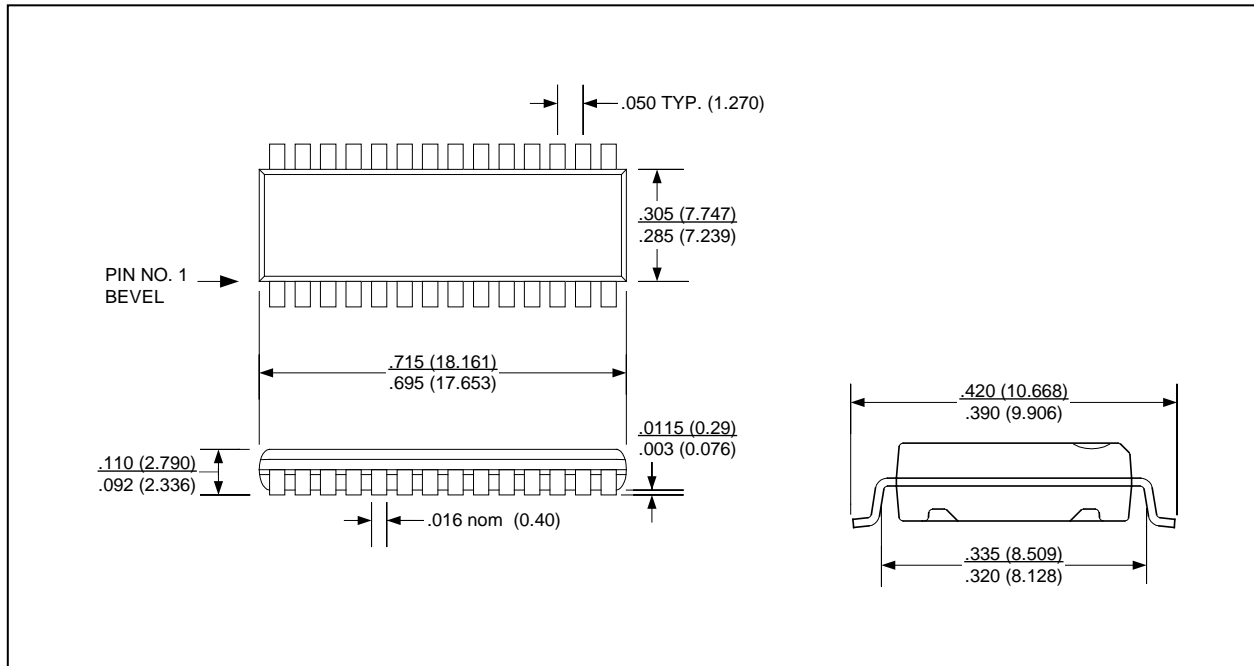


Figure 12: 28 Lead SO

## 15 Package Pin Designation (28-SO)



Use handling procedures necessary for a static sensitive component.

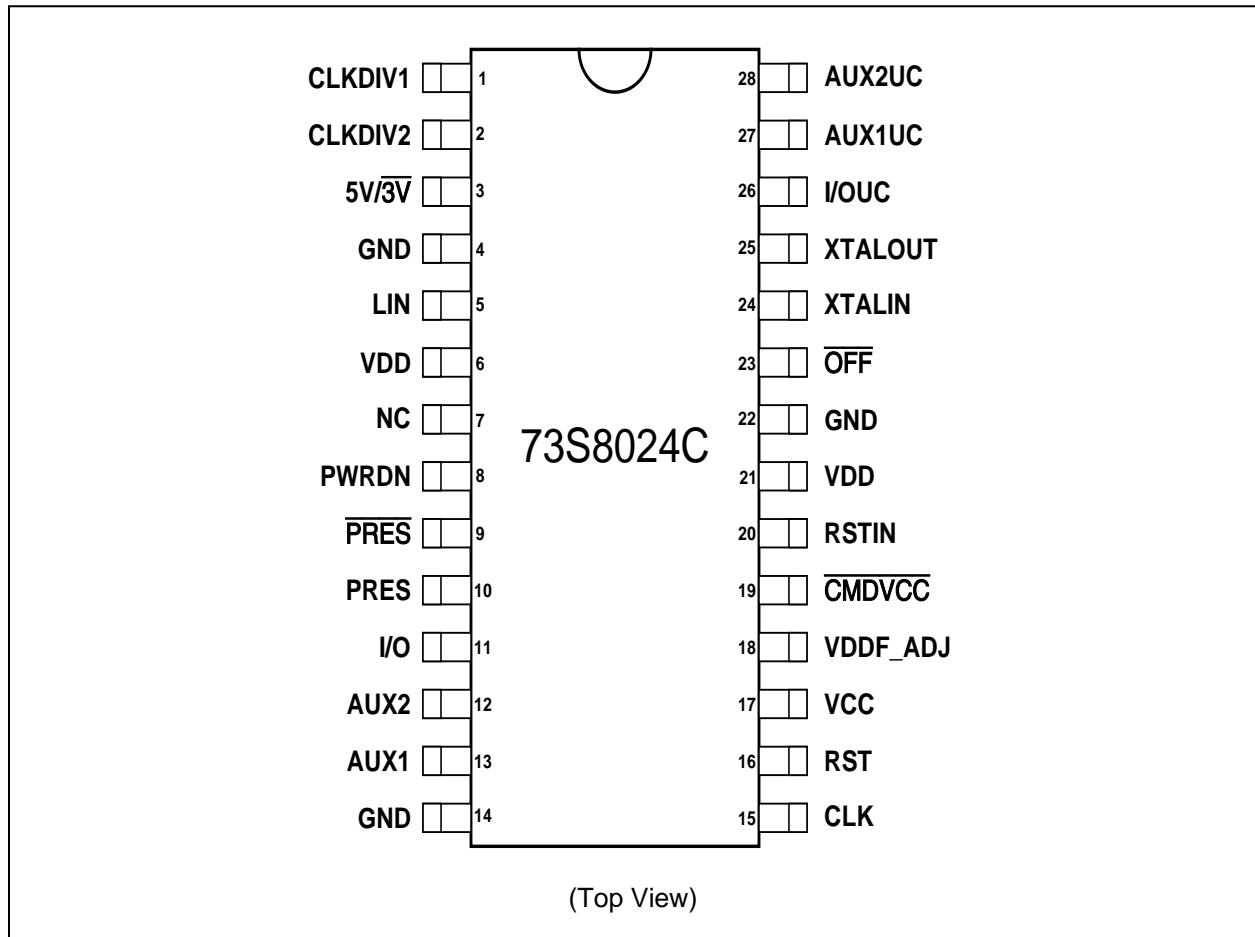


Figure 11: 73S8024C 28-SO Pin Out

## 16 Ordering Information

Part Description	Order Number	Packaging Mark
73S8024C-SO 28-pin Lead-Free SO	73S8024C-IL/F	73S8024C-IL
73S8024C-SO 28-pin Lead-Free SO Tape / Reel	73S8024C-ILR/F	73S8024C-IL

## 17 Related Documentation

The following 73S8024C documents are available from Teridian Semiconductor Corporation:

*73S8024C Data Sheet* (this document)

*73S8024C Demo Board User's Guide*

## 18 Contact Information

For more information about Teridian Semiconductor products or to check the availability of the 73S8024C, contact us at:

6440 Oak Canyon Road  
Suite 100  
Irvine, CA 92618-5201

Telephone: (714) 508-8800  
FAX: (714) 508-8878  
Email: [scr.support@teridian.com](mailto:scr.support@teridian.com)

For a complete list of worldwide sales offices, go to <http://www.teridian.com>.

## Revision History

Revision	Date	Description
1.0	6/21/2005	First publication.
1.1	7/15/2005	Removed QFN package information.
1.2	12/5/2007	Add ISO and EMV logos, remove leaded package option, update 28SO package dimension.
1.3	4/3/2009	Remove all references to VPC as VPC must be tied to VDD.

© 2009 Teridian Semiconductor Corporation. All rights reserved.

Teridian Semiconductor Corporation is a registered trademark of Teridian Semiconductor Corporation.

Simplifying System Integration is a trademark of Teridian Semiconductor Corporation.

All other trademarks are the property of their respective owners.

Teridian Semiconductor Corporation makes no warranty for the use of its products, other than expressly contained in the Company's warranty detailed in the Teridian Semiconductor Corporation standard Terms and Conditions. The company assumes no responsibility for any errors which may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice and does not make any commitment to update the information contained herein. Accordingly, the reader is cautioned to verify that this document is current by comparing it to the latest version on <http://www.teridian.com> or by checking with your sales representative.

Teridian Semiconductor Corp., 6440 Oak Canyon Rd., Suite 100, Irvine, CA 92618  
TEL (714) 508-8800, FAX (714) 508-8877, <http://www.Teridian.com>