TDK SEMICONDUCTOR CORP.

73S8024R
Low Cost Smart Card Interface

DATA-SHEET

April 2004

ISO/IEC 7816-3

EMVCo

DESCRIPTION

The TDK 73S8024R is a single smart card (ICC) interface IC that can be controlled by a dedicated control bus. The TDK 73S8024R has been designed to provide full electrical compliance with ISO-7816-3, EMV 4.0 (EMV2000) and NDS specifications.

Interfacing with the system controller is done through a 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.

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

TDK 73S8024R incorporates an ISO-7816-3 activation/deactivation sequencer that controls the card signals. Level-shifters drive the card signals with the selected card voltage (3V or 5V), coming from an internal Low Drop-Out (LDO) voltage regulator. This LDO regulator is powered by a dedicated power supply input V_{PC}. Digital circuitry is separately powered by a digital power supply V_{DD}.

With its embedded LDO regulator, the TDK 73S8024R is a cost-effective solution for any application where a 5V (typically -5% +10%) power supply is available.
Hardware support for auxiliary I/O lines, C4 / C8 contacts, is provided.

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

The card over-current circuitry is a true current detection function, as opposed to V_{CC} voltage drop detection, as usually implemented in ICC interface ICs.

The V_{DD} voltage fault has a threshold voltage that can be adjusted with an external resistor or resistor network. It allows automated card deactivation at a customized V_{DD} voltage threshold value. It can be used, for instance, to match the system controller operating voltage range.

APPLICATIONS

- **Set-Top-Box Conditional Access and Pay-per-View**
- **Point of Sales & Transaction Terminals**
- **Control Access & Identification**

ADVANTAGES

- **Traditional step-up converter is replaced by a LDO regulator:**
  - → **Fewer external components are required**
  - → **Better noise performance**
  - → **High current capability (90mA supplied to the card)**
- **Pin-to-pin compatible with industry-standards TDA8004 and TDA-8024**
- **Card clock STOP (high and low) mode**
- **Small format (5x5x0.8mm) 32QFN package option**
- **True card over-current detection**

FEATURES

- **Card Interface:**
  - **Complies w/ ISO-7816-3, EMV 4.0 & NDS Specs**
  - **A LDO voltage regulator provides 3V / 5V to the card from an external power supply input**
  - **Provides at least 90mA 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 3 voltage supervisors that detect voltage drops on V_{CC} (card), V_{DD} (digital), and V_{PC} (regulator) power supplies
  - The V_{DD} voltage supervisor threshold value can be externally adjusted
  - Over-current detection 150mA max.
  - Card clock stop high or low
  - 2 card detection inputs, 1 for either possible user polarity
  - Auxiliary I/O lines for C4 and C8 contact signals
  - Card CLK frequency up to 13.5MHz (NDS applications)
- **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 controller to monitor the card presence and faults.
  - Crystal oscillator or host clock, up to 32MHz
- **Regulator Power Supply:**
  - 4.75V to 5.5V (EMV 4.0)
  - 4.85V to 5.5V (NDS)
- **Digital Interfacing:**
  - 2.7V to 5.5V (ISO7816 / EMV 4.0)
  - 3.0V to 3.6V (NDS)
- **6kV ESD Protection on the card interface**
- **Package: SO28 or 32QFN**

FUNCTIONAL DIAGRAM

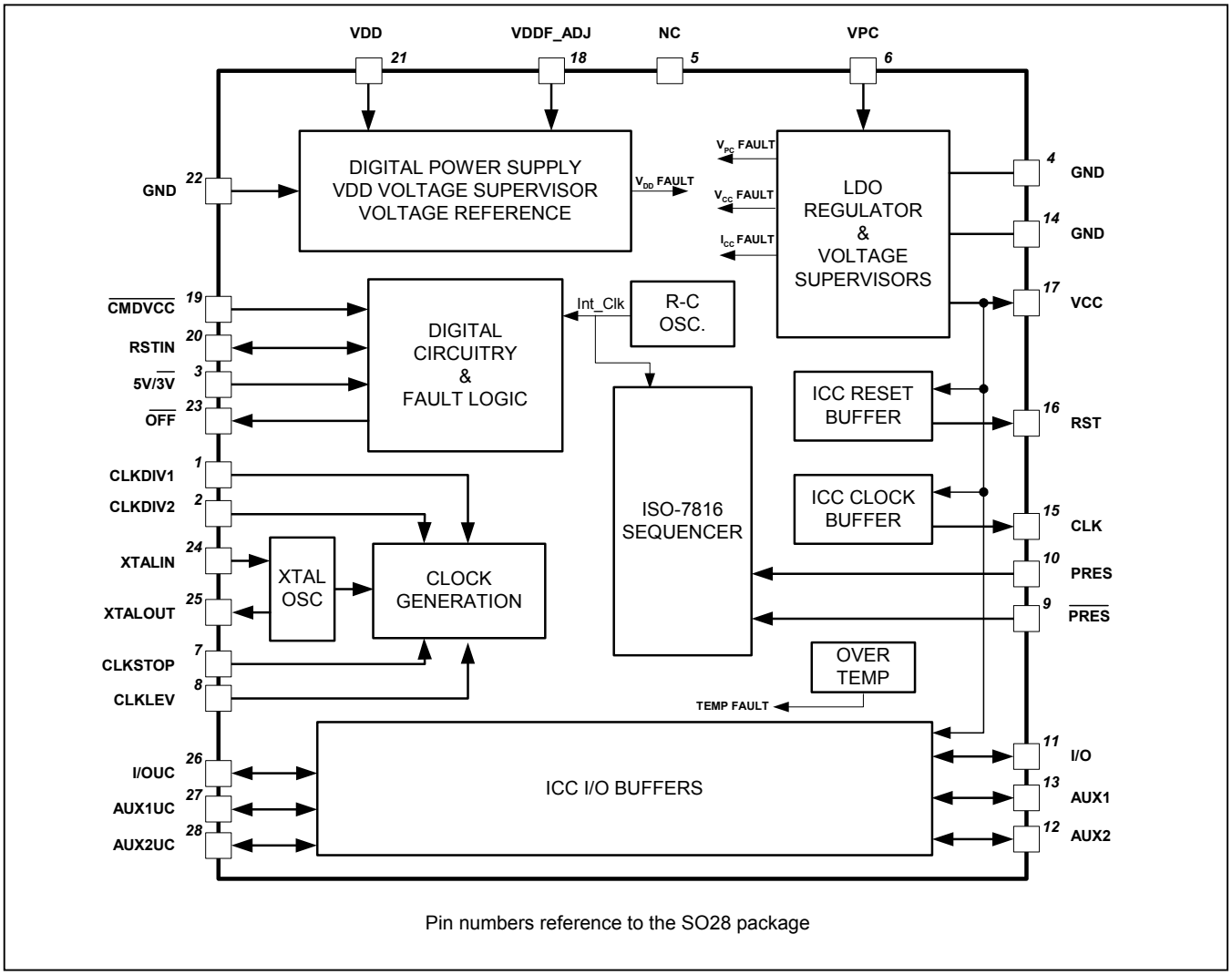


Figure 1: 73S8024R Block Diagram

PIN DESCRIPTION

CARD INTERFACE

NAME	PIN (SO)	PIN (QFN)	DESCRIPTION
I/O	11	8	Card I/O: Data signal to/from card. Includes a pull-up resistor to $V_{CC.}$
AUX1	13	11	AUX1: Auxiliary data signal to/from card. Includes a pull-up resistor to $V_{CC.}$
AUX2	12	10	AUX2: Auxiliary data signal to/from card. Includes a pull-up resistor to $V_{CC.}$
RST	16	14	Card reset: provides reset (RST) signal to card.
CLK	15	13	Card clock: provides clock signal (CLK) to card. The rate of this clock is determined by the external crystal frequency or frequency of the external clock signal applied on XTALIN and CLKDIV selections.
PRES	10	7	Card Presence switch: active high indicates card is present. Should be tied to GND when not used, but it Includes a high-impedance pull-down current source.
$\overline{\text{PRES}}$	9	6	Card Presence switch: active low indicates card is present. Should be tied to V_{DD} when not used, but it Includes a high-impedance pull-up current source.
VCC	17	15	Card power supply – logically controlled by sequencer, output of LDO regulator. Requires an external filter capacitor to the card GND
GND	14	12	Card ground

MISCELLANEOUS INPUTS AND OUTPUTS

NAME	PIN (SO)	PIN (QFN)	DESCRIPTION
XTALIN	24	23	Crystal oscillator input: can either be connected to crystal or driven as a source for the card clock.
XTALOUT	25	24	Crystal oscillator output: connected to crystal. Left open if XTALIN is being used as external clock input.
VDDF_ADJ	18	17	V_{DD} fault threshold adjustment input: this pin can be used to adjust the V_{DDF} values (that controls deactivation of the card). Must be left open if unused.
NC	5	9, 16, 25, 32	Non-connected pin.

POWER SUPPLY AND GROUND

NAME	PIN (SO)	PIN (QFN)	DESCRIPTION
VDD	21	20	System interface supply voltage and supply voltage for internal circuitry.
VPC	6	3	LDO regulator power supply source.
GND	4	1	LDO Regulator ground.
GND	22	21	Digital ground.

MICROCONTROLLER INTERFACE

NAME	PIN (SO)	PIN (QFN)	DESCRIPTION
$\overline{\text{CMDVCC}}$	19	18	Command VCC (negative assertion): Logic low on this pin causes the LDO regulator to ramp the V_{CC} supply to the card and initiates a card activation sequence, if a card is present.
5V/$\overline{\text{3V}}$	3	31	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 5V card) when not connected.
CLKSTOP	7	4	Stops the card clock signal during a card session when asserted (card clock STOP mode). Internal pull-down resistor allows this pin to be left as an open circuit if the clock STOP mode is not used.
CLKLVL	8	5	Sets the logic level of the card clock STOP mode when the clock is de-activated by assertion of the pin 7. Logic low selects card STOP low. Logic high selects card STOP high. Internal pull-down resistor allows this pin to be left as an open circuit if the clock STOP mode is not used.
CLKDIV1 CLKDIV2	1 2	29 30	Sets the divide ratio from the XTAL oscillator (or external clock input) to the card clock. These pins include pull-down resistors. CLKDIV1 / CLKDIV2 / CLOCK RATE 0 / 0 / XTALIN/8 0 / 1 / XTALIN/4 1 / 1 / XTALIN/2 1 / 0 / XTALIN
$\overline{\text{OFF}}$	23	22	Interrupt signal to the processor. Active Low - Multi-function indicating fault conditions and card presence. Open drain output configuration – It includes an internal 22kΩ pull-up to V_{DD}.
RSTIN	20	19	Reset Input: This signal is the reset command to the card.
I/OUC	26	26	System controller data I/O to/from the card. Includes a pull-up resistor to V_{DD}.
AUX1UC	27	27	System controller auxiliary data I/O to/from the card. Includes a pull-up resistor to V_{DD}.
AUX2UC	28	28	System controller auxiliary data I/O to/from the card. Includes a pull-up resistor to V_{DD}.

SYSTEM CONTROLLER INTERFACE

3 separated digital inputs allow direct control of the card interface from the host as follows:

- Pin $\overline{\text{CMDVCC}}$: When low, starts an activation sequence
- Pin RSTIN: controls the card Reset signal (when enabled by the sequencer)
- Pin 5V/$\overline{\text{3V}}$: Defines the card voltage

Card clock is controlled by 4 digital inputs:

- CLKDIV1 and CLKDIV2 define the division rate for the clock frequency, from the input clock frequency (crystal or external clock)
- CLKSTOP (active high) allows card power down mode by stopping the card clock
- CLKLEV defines the card clock level of the card power down mode.

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 asserted Low (Card activation sequence requested from the host), Low level on $\overline{\text{OFF}}$ means a fault has been detected (e.g. card removal during card session, or voltage fault, or thermal / over-current fault) that automatically initiates a deactivation sequence.

POWER SUPPLY AND VOLTAGE SUPERVISON

The TDK 73S8024R smart card interface IC incorporates a LDO voltage regulator. The voltage output is controlled by the digital input 5V/$\overline{3V}$. This regulator is able to provide either 3V or 5V card voltage from the power supply applied on the VPC pin.

Digital circuitry is powered by the power supply applied on the VDD pin. V_{DD} also defines the voltage range to interface with the system controller.

Three voltage supervisors constantly check the presence of the voltages V_{DD}, V_{PC} and V_{CC}. A card deactivation sequence is forced upon fault of any of these voltage supervisors. The two voltage supervisors for V_{PC} and V_{CC} are linked so that a fault is generated to activate a deactivation sequence when the voltage V_{PC} becomes lower than V_{CC}. It allows the 73S8024R to operate at lower V_{PC} voltage when using 3V cards only. The voltage regulator can provide a current of at least 90mA on V_{CC} that comply easily with EMV 4.0 and NDS specifications. The V_{PC} voltage supervisor threshold values are defined from applicable standards (EMV and NDS). A third voltage supervisor monitors the V_{DD} voltage. It is used to initialize the ISO-7816-3 sequencer at power-on, and to deactivate the card at power-off or upon fault. The voltage threshold of the V_{DD} voltage supervisor is internally set by default to 2.3V 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:

$$R_{EXT} = 56k\Omega / (V_{DDF} - 2.33)$$

When this capability is not used, the VDDF_ADJ must be left open.

An alternative method (more accurate) 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 applications diagram). 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). Kx is calculated as:

$Kx = (2.789 / V_{TH}) - 0.6125$ where V_{TH} is the desired new threshold voltage.

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

$R3 = 24000 / Kx$ $\quad R1 = R3*(Kx / (1 – Kx))$

Taking the example above, where a VDD fault threshold voltage of 2.7V is desired, solving for Kx gives:
→ Kx = (2.789 / 2.7) - 0.6125 = 0.42046.
Solving for R3 gives: → R3 = 24000 / 0.42046 = 57080.
Solving for R1 gives: → R1 = 57080 *(0.42046 / (1 – 0.42046)) = 41412.
Using standard 1 % resistor values gives R3 = 57.6KΩ and R1 = 42.4KΩ.
These values give an equivalent resistance of Kx = 0.4228, a 0.6% error.

Again, if the 2.3V default threshold is acceptable, this pin must be left unconnected.

CARD POWER SUPPLY

The card power supply is internally provided by the LDO regulator, and controlled by the digital ISO-7816-3 sequencer. Card voltage selection is carried out by the digital input 5V/$\overline{3V}$.

Choice of the V_{CC} capacitor:

Depending on the applications, the requirements in terms of both V_{CC} minimum voltage and transient currents that the interface must be able to provide to the card are different. An external capacitor must be connected between the VCC pin and to the card ground in order to guarantee stability of the LDO regulator, and to handle the transient requirements. The type and value of this capacitor can be optimized to meet the desired specification. The table below shows the recommended capacitors for each V_{PC} power supply configuration and applicable specification.

Specification Requirements			System Requirements		
Specification	**Min V_{CC} Voltage allowed during transient current**	**Max transient current charge**	**Min V_{PC} Power Supply required**	**Capacitor Type**	**Capacitor Value +/-20%**
EMV 4.0	4.6V	30nA.s	4.75V	X5R/X7R w/ ESR < 100mΩ	3.3 µF
ISO-7816-3	4.5V	20nA.s	4.75V		1 µF
NDS	4.6V	40nA.s	4.85V		1 µF

Table 1: Choice of V_{CC} pin capacitor

Note: Capacitor value for NDS implementation is also defined by the deactivation time requirement.

OVER-TEMPERATURE MONITOR

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

ON-CHIP OSCILLATOR AND CARD CLOCK

The TDK 73S8024R 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 clock signal is available from another source, it can be connected to the pin XTALIN, and the pin XTALOUT should be left unconnected.

The card clock frequency may be chosen between 4 different division rates, defined by digital inputs CLKDIV 1 and CLKDIV 2, as per the following table:

CLKDIV1	CLKDIV2	CLK
0	0	1/8 XTALIN
0	1	¼ XTALIN
1	0	XTALIN
1	1	½ XTALIN

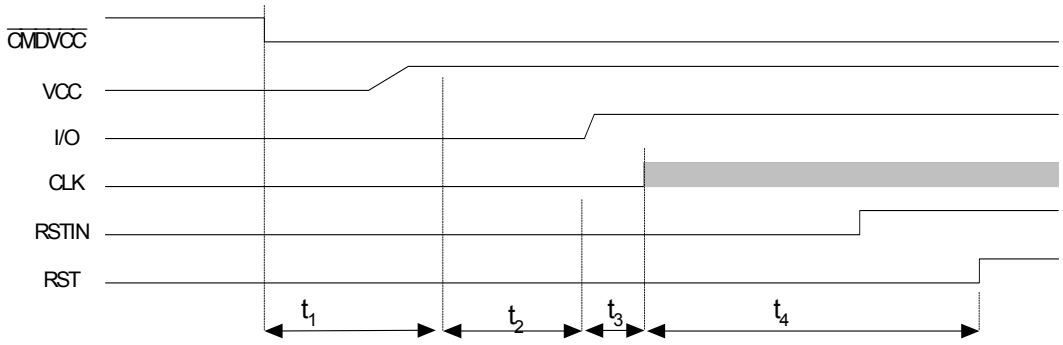
Card power down mode (card clock STOP) is supported and is controllable through the dedicated digital inputs CLKSTOP and CLKLEV.

ACTIVATION SEQUENCE

The TDK 73S8024R smart card interface IC has an internal 10ms delay at power on reset or on the application of VDD > VDDF. No activation is allowed at this time. The $\overline{\text{CMDVCC}}$ (edge triggered) must then be asserted low to activate the card. In order to initiate activation, the card must be present, there can be no over-temperature fault or no V_{DD} fault.

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

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

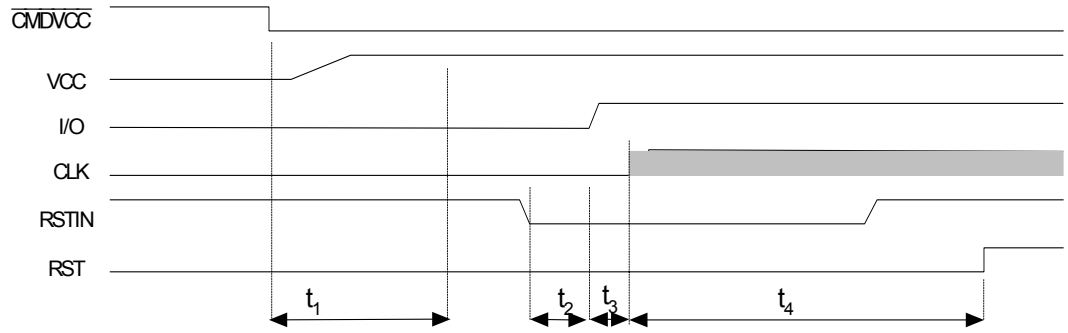


t_1 = 0.510 ms (timing by 1.5MHz internal Oscillator)
t_2 = 1.5μs, I/O goes to reception state
t_3 = >0.5μs, CLK starts
t_4 = 42000 card clock cycles. Time for RST to become the copy of RSTIN

Figure 2: Activation Sequence – RSTIN low when $\overline{\text{CMDVCC}}$ goes low

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

- $\overline{\text{CMDVCC}}$ is asserted low.
- Next, the internal V_{CC} control circuit checks the presence of V_{CC} during t_1. In normal operation, the voltage V_{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 power V_{CC} to the card is de-asserted.
- Turn I/O (AUX1, AUX2) to reception mode at the end of (t_2).
- Due to fall of RSTIN, CLK is applied to the card at the end of (t_3).
- RST is to be a copy of RSTIN after (t_4). If RSTIN is high prior to t_4, RST will de-assert at t_4.



t_1 = 0.510 ms (timing by 1.5MHz internal Oscillator)
t_2 = 1.5μs, I/O goes to reception state
t_3 = > 0.5μs, CLK active
t_4 = 42000 card clock cycles. Time for RST to become the copy of RSTIN

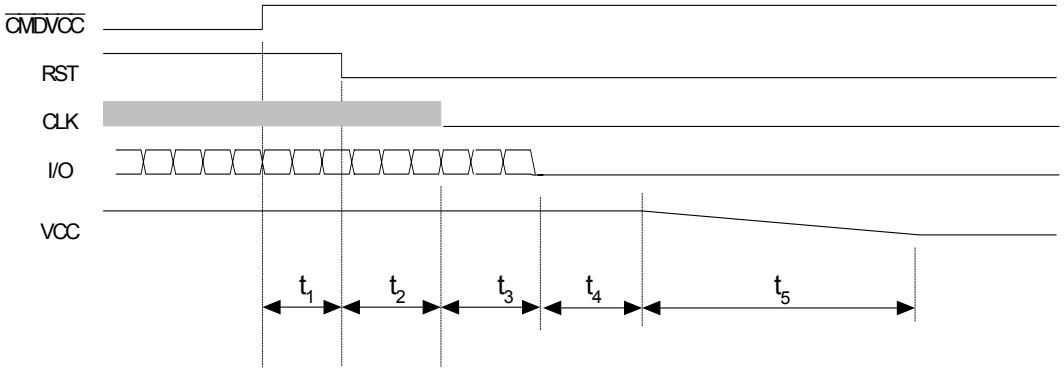
Figure 3: Activation Sequence – RSTIN high when $\overline{\text{CMDVCCB}}$ goes low

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_{DD} fault, V_{PC} fault, V_{CC} fault, and card extraction during the session. To be noted that V_{PC} and V_{CC} faults are linked together so that a fault is generated when V_{PC} goes lower than V_{CC}.

The following steps show the deactivation sequence and the timing of the card control signals when the system controller sets the $\overline{\text{CMDVCC}}$ high:

- RST goes low at the end of time t_1.
- De-assert CLK at the end of time t_2.
- I/O goes low at the end of time t_3. Out of reception mode.
- V_{CC} is turned off at the end of time t_4. After a delay t_5 (discharge of the V_{CC} capacitor), V_{CC} is low.



t_1 = > 0.5µs, timing by 1.5MHZ internal Oscillator
t_2 = > 7.5µs
t_3 = > 0.5µs
t_4 = > 0.5µs
t_5 = depends on V_{CC} filter capacitor. For NDS application,
C_F=1µF makes $t_1 + t_2 + t_3 + t_4 + t_5$ < 100µs

Figure 4: Deactivation Sequence

$\overline{\text{OFF}}$ AND FAULT DETECTION

There are two different cases that 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.

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.
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 detection is detected. At the same time that $\overline{\text{OFF}}$ is asserted low, the sequencer starts the deactivation process.

The Figure 5 shows the timing diagram for the signals $\overline{\text{CMDVCC}}$, PRES, and $\overline{\text{OFF}}$ during a card session and outside the card session:

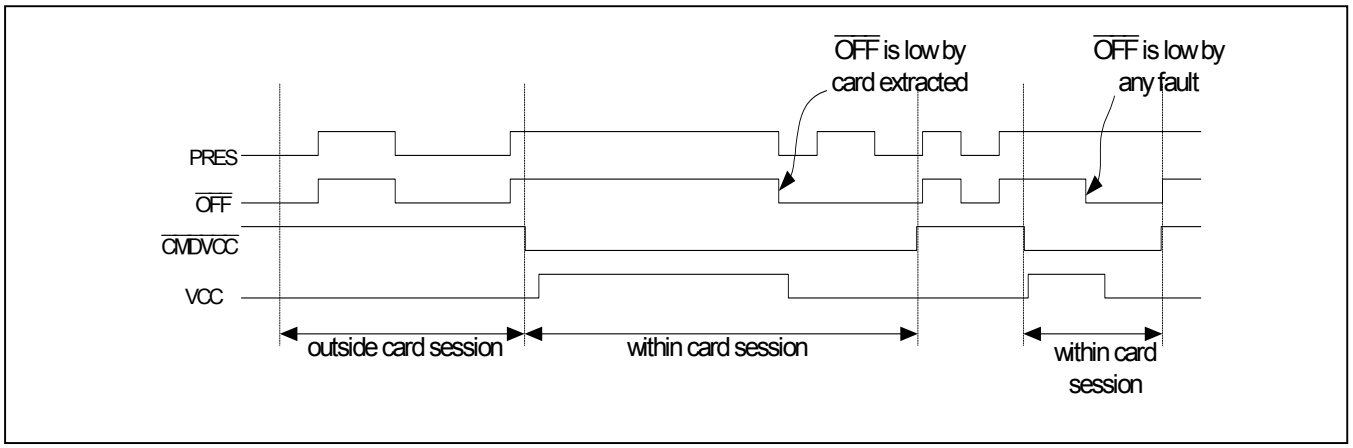


Figure 5: Timing Diagram - Management of the Interrupt Line $\overline{\text{OFF}}$

I/O CIRCUITRY AND TIMING

The state of the I/O, AUX1, and AUX2 pins is in low state after power on reset and they are in high state when the activation sequencer turns on the I/O reception state. See Activation Sequence timing section 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 turn 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 then both I/O lines return to their neutral state.
The Figure 6 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 7.

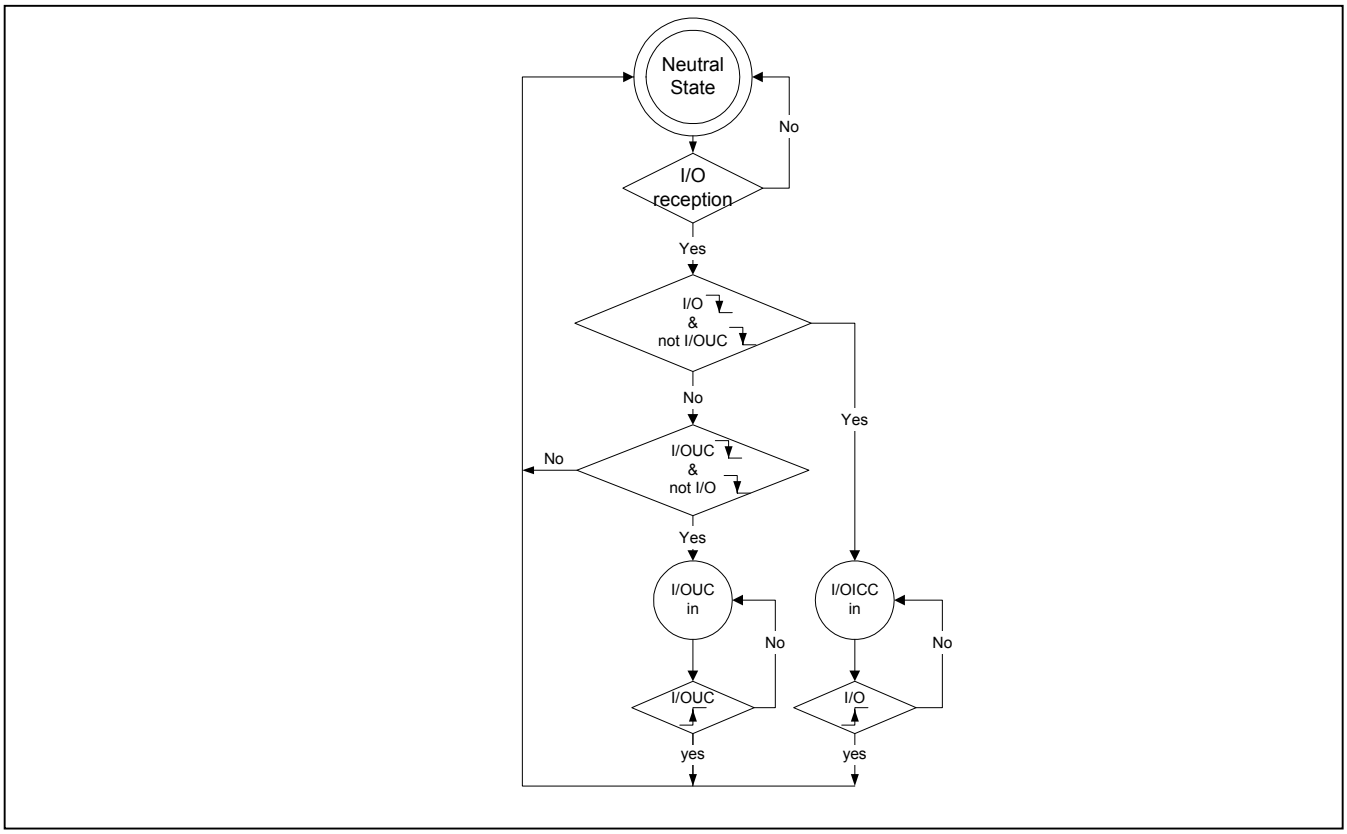


Figure 6: I/O and I/OUC State Diagram

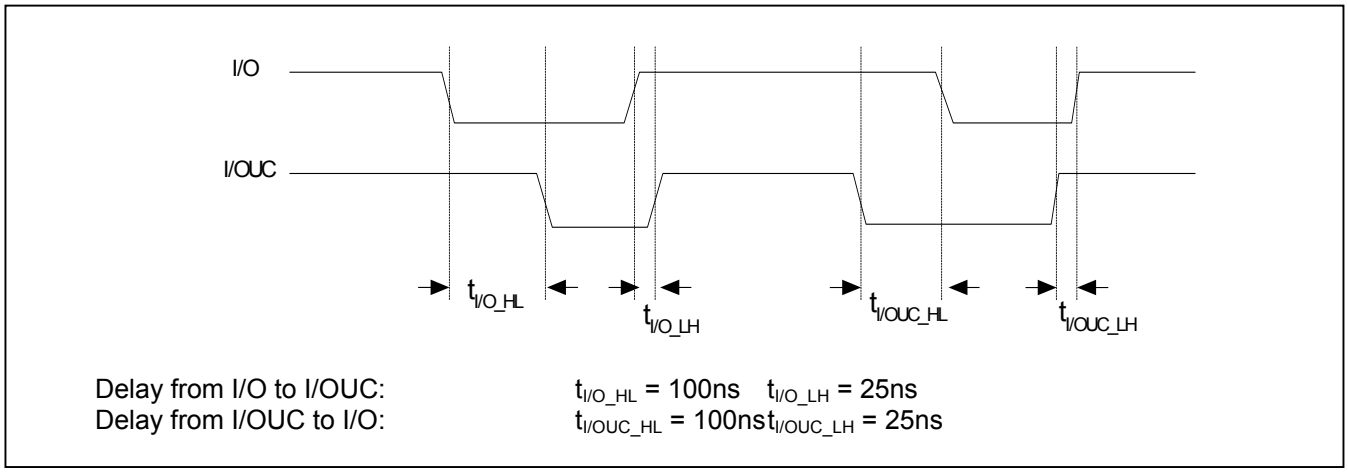


Figure 7: I/O – I/OUC Delays - Timing Diagram

TYPICAL APPLICATION SCHEMATIC

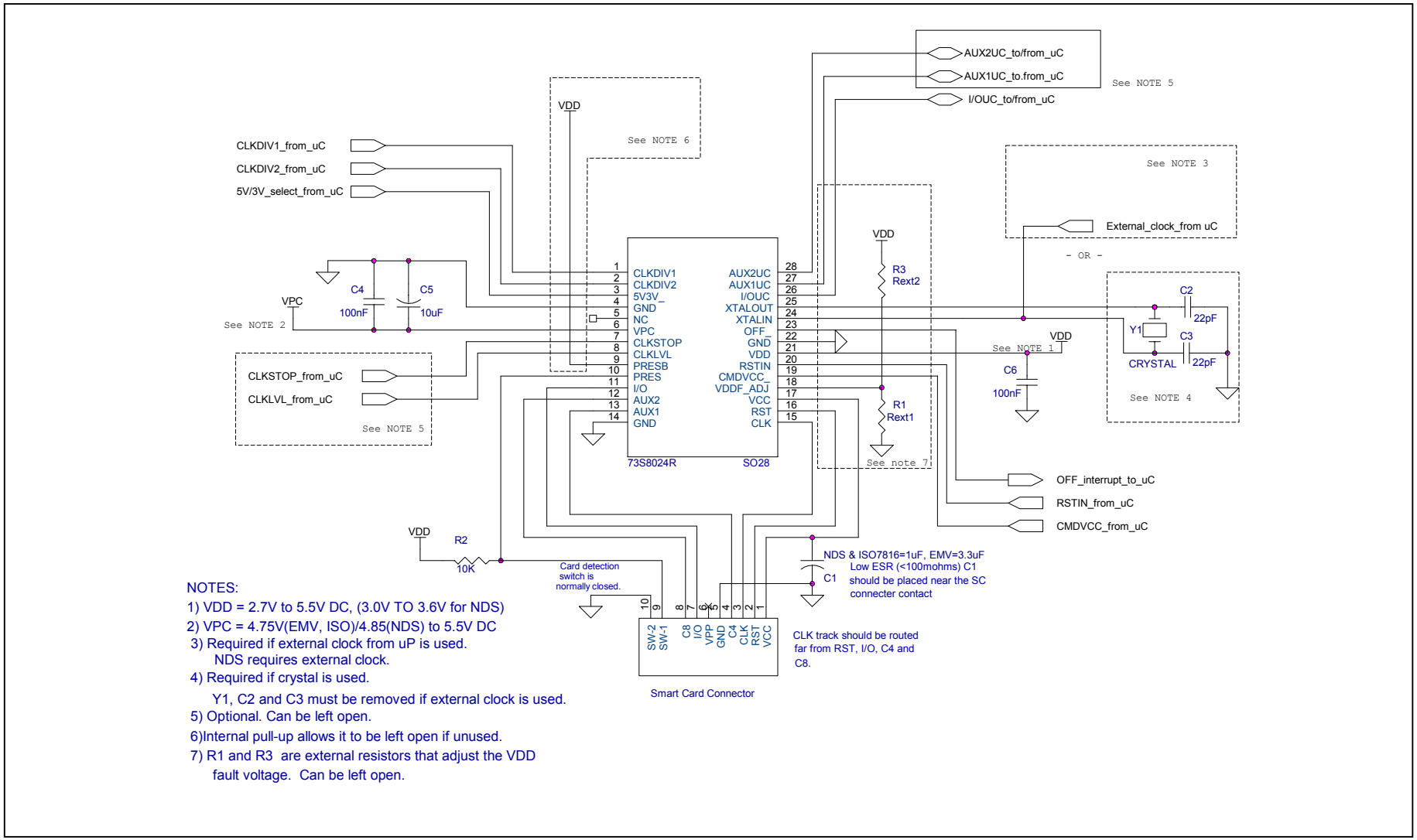


Figure 8: 73S8024R – Typical Application Schematic

ELECTRICAL SPECIFICATION

ABSOLUTE MAXIMUM RATINGS

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

PARAMETER	RATING
Supply Voltage V_{DD}	-0.5 to 6.0 VDC
Supply Voltage V_{PC}	-0.5 to 6.0 VDC
Input Voltage for Digital Inputs	-0.3 to (VDD+0.5) VDC
Storage Temperature	-60 to 150°C
Pin Voltage	-0.3 to (VDD+0.5) VDC
Pin Current	±100mA
ESD Tolerance – Card interface pins*	+/- 6kV
ESD Tolerance – Other pins	+/- 2kV

Note*: ESD testing on smart card pins is HBM condition, 3 pulses, each polarity referenced to ground.
Note: Smart Card pins are protected against shorts between any combinations of Smart Card pins.

RECOMMENDED OPERATING CONDITIONS

PARAMETER	RATING
Supply Voltage V_{DD}	2.7 to 5.5 VDC
NDS Supply Voltage V_{DD}	3.0 to 3.6 VDC
Supply Voltage V_{PC}	4.75 to 5.5 VDC
NDS Supply Voltage V_{PC}	4.85 to 5.5 VDC
Ambient Operating Temperature	-40°C to +85°C
Input Voltage for Digital Inputs	0V to VDD + 0.3V

SMART CARD INTERFACE REQUIREMENTS

SYMBOL	PARAMETER	Condition	MIN	Typ.	MAX	UNIT
Card Power Supply (V_{CC}) Regulator ***General conditions, -40°C < T < 85°C, 4.75v < V_{PC} < 5.5v, 2.7v < V_{DD} < 5.5v*** ***NDS conditions, 0°C < T < 85°C, 4.85v < V_{PC} < 5.5v, 3.0v < V_{DD} < 3.6v***						
V_{CC}	Card supply voltage including ripple and noise	Inactive mode	-0.1		0.1	V
		Inactive mode I_{CC} = 1mA	-0.1		0.4	V
		Active mode; I_{CC} <65mA; 5v	4.60		5.25	V
		Active mode; I_{CC} <65mA; 5v, NDS condition	4.75		5.25	V
		Active mode; I_{CC} <90mA; 5v	4.55		5.25	V
		Active mode; I_{CC} <90mA; 3v	2.80		3.2	V
		Active mode; single pulse of 100mA for 2μs; 5 volt, fixed load = 25mA	4.6		5.25	V
		Active mode; single pulse of 100mA for 2μs; 3v, fixed load = 25mA	2.76		3.2	V
		Active mode; current pulses of 40nAs with peak $\|I_{CC}\|$ <200mA, t <400ns; 5v	4.6		5.25	V
		Active mode; current pulses of 40nAs with peak $\|I_{CC}\|$ <200mA, t <400ns; 5v, NDS condition	4.65		5.25	V
		Active mode; current pulses of 40nAs with peak $\|I_{CC}\|$ <200mA, t <400ns; 3v	2.76		3.2	V
V_{CCrip}	V_{CC} Ripple	f_{RIPPLE} = 20K – 200MHz			350	mV
I_{CCmax}	Card supply output current	Static load current, V_{CC}>4.6	65			mA
		Static load current, V_{CC}>4.55 or 2.7 volts as selected	90			mA
I_{CCF}	I_{CC} fault current		90		150	mA
V_{SR} - V_{SF}	V_{CC} slew rate -	C_F = 3.3μF on V_{CC}	0.02	0.050	0.08	V/μs
V_{SRN} - V_{SFN}	V_{CC} slew rate	C_F = 1.0μF on V_{CC} NDS applications	0.06	0.160	0.26	V/μs
C_F	External filter capacitor (V_{CC} to GND)	C_F should be ceramic with low ESR (<100mΩ).	1	3.3	5	μF
C_{FNDS}	External filter capacitor (V_{CC} to GND)	NDS applications C_F should be ceramic with low ESR (<100mΩ).	0.5	1.0	1.5	μF

SYMBOL	PARAMETER	Condition	MIN	Typ.	MAX	UNIT
Interface Requirements – Data Signals: I/O, AUX1, AUX2, and host interfaces: I/OUC, AUX1UC, AUX2UC. I_{SHORTL}, I_{SHORTH}, and V_{INACT} requirements do not 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} = -40μA	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} = -40μA	0.75 V_{DD}		V_{DD}+0.1	V
V_{OL}	Output level, low	I_{OL}=1mA			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} = 1mA			0.3	V
I_{LEAK}	Input leakage	V_{IH} = V_{CC}			10	μA
I_{IL}	Input current, low	V_{IL} = 0			0.65	mA
I_{SHORTL}	Short circuit output current	For output low, shorted to V_{CC} through 33 ohms			15	mA
I_{SHORTH}	Short circuit output current	For output high, shorted to ground through 33 ohms			15	mA
t_R, t_F	Output rise time, fall times	For I/O, AUX1, AUX2, C_L = 80pF, 10% to 90%. For IOUC, AUX1UC, AUX2UC, CL=50Pf, 10% to 90%.			100	ns
t_{IR}, t_{IF}	Input rise, fall times				1	μs
R_{PU}	Internal pull-up resistor	Output stable for >200ns	8	11	14	kΩ
FD_{MAX}	Maximum data rate				1	MHz
T_{FDIO}	Delay, I/O to I/OUC, AUX1 to AUX1UC, AUX2 to AUX2UC, I/OUC to I/O, AUX1UC to AUX1, AUX2UC to AUX2 (respectively falling edge to falling edge and rising edge to rising edge)	Edge from master to slave, measured at 50%	60	100	200	ns
T_{RDIO}				25	90	ns
C_{IN}	Input capacitance				10	pF

SYMBOL	PARAMETER	Condition	MIN	Typ.	MAX	UNIT
Reset and Clock for card interface, RST, CLK						
V_{OH}	Output level, high	I_{OH} =-200µA	0.9 V_{CC}		V_{CC}	V
V_{OL}	Output level, low	I_{OL}=200µA	0		0.3	V
V_{INACT}	Output voltage when outside of session	I_{OL} = 0			0.1	V
		I_{OL} = 1mA			0.3	V
I_{RST_LIM}	Output current limit, RST				30	mA
I_{CLK_LIM}	Output current limit, CLK				70	mA
CLK_{SR3V}	CLK slew rate	Vcc = 3V	0.3			V/ns
CLK_{SR5V}	CLK slew rate	Vcc = 5V	0.5			V/ns
t_R, t_F	Output rise time, fall time	C_L = 35pF for CLK, 10% to 90%			8	ns
		C_L = 200pF for RST, 10% to 90%			100	ns
δ	Duty cycle for CLK	C_L =35pF Card clock rate ≠ XTALIN ÷ 1*	45		55	%

Note*: Reference application note, “Implementing the TDK 73S8024R in NDS Applications” (AN_8024R_001) for card clock rate = XTALIN ÷ 1.

DC CHARACTERISTICS: DIGITAL SIGNALS

SYMBOL	PARAMETER	Condition	MIN	Typ.	MAX	UNIT
Digital I/O except for OSC I/O						
V_{IL}	Input Low Voltage		-0.3		0.8	V
V_{IH}	Input High Voltage		0.7 V_{DD}		V_{DD} + 0.3	V
V_{OL}	Output Low Voltage	I_{OL} = 2mA			0.45	V
V_{OH}	Output High Voltage	I_{OH} = -1mA	V_{DD} - 0.45			V
R_{OUT}	Pull-up resistor, $\overline{OFF}$			20		kΩ
$\|I_{IL1}\|$	Input Leakage Current	GND < V_{IN} < V_{DD}			5	µA
Oscillator (XTALIN) I/O Parameters						
V_{ILXTAL}	Input Low Voltage - XTALIN		-0.3		0.3 V_{DD}	V
V_{IHXTAL}	Input High Voltage - XTALIN		0.7 V_{DD}		V_{DD}+0.3	V
I_{ILXTAL}	Input Current - XTALIN	GND < V_{IN} < V_{DD}	-30		30	µA
f_{MAX}	Max freq. with oscillator				27	MHz
	Max freq. with external clock				32	

DC CHARACTERISTICS

SYMBOL	PARAMETER	Condition	MIN	Typ.	MAX	UNIT
I_{DD}	Supply Current			1.5	3.0	mA
I_{PC}	Supply Current	VCC on, ICC=0 I/O, AUX1, AUX2=high, Clock not toggling		0.45	0.65	mA
I_{PCOFF}	V_{PC} supply current when V_{CC}=0			345	750	µA
	V_{PC} supply current when V_{CC}=On			450	800	

VOLTAGE / TEMPERATURE FAULT DETECTION CIRCUITS

SYMBOL	PARAMETER	Condition	MIN	Typ.	MAX	UNIT
V_{DDF}	V_{DD} fault (V_{DD} Voltage supervisor threshold)	No external resistor on VDDF_ADJ pin	2.2		2.4	V
V_{PCF}	V_{PC} fault (V_{PC} Voltage supervisor threshold)	V_{PC}<V_{CC}, a transient event		V_{CC} - 0.2		V
V_{CCF}	V_{CC} fault (V_{CC} Voltage supervisor threshold)	V_{CC} = 5v	4.20		4.55	V
		V_{CC}= 3v	2.5		2.7	V
T_F	Die over temperature fault		115		145	°C

MECHANICAL DRAWING (QFN)

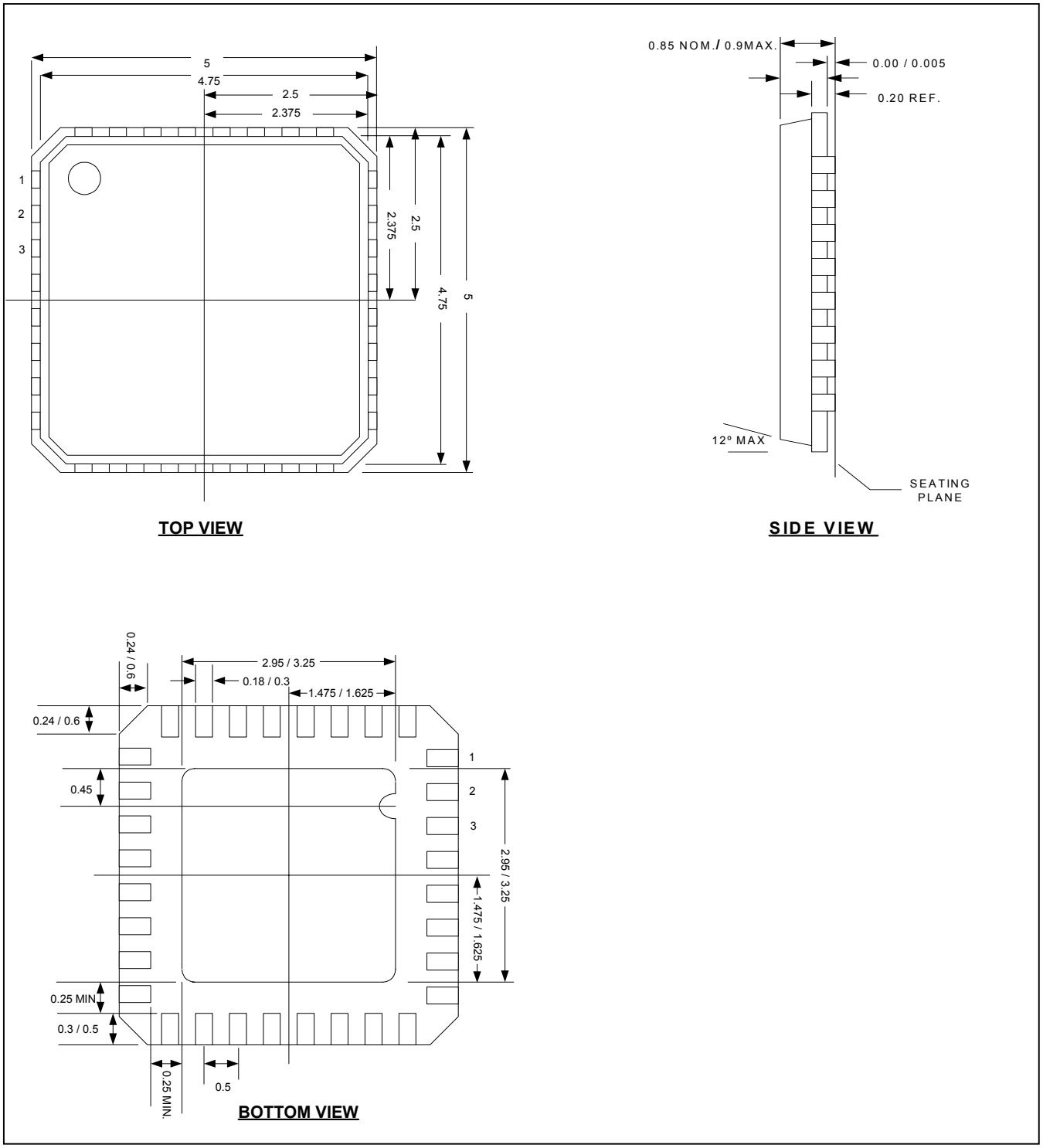


Figure 9: 32QFN

PACKAGE PIN DESIGNATION (QFN)

CAUTION: Use handling procedures necessary for a static sensitive component

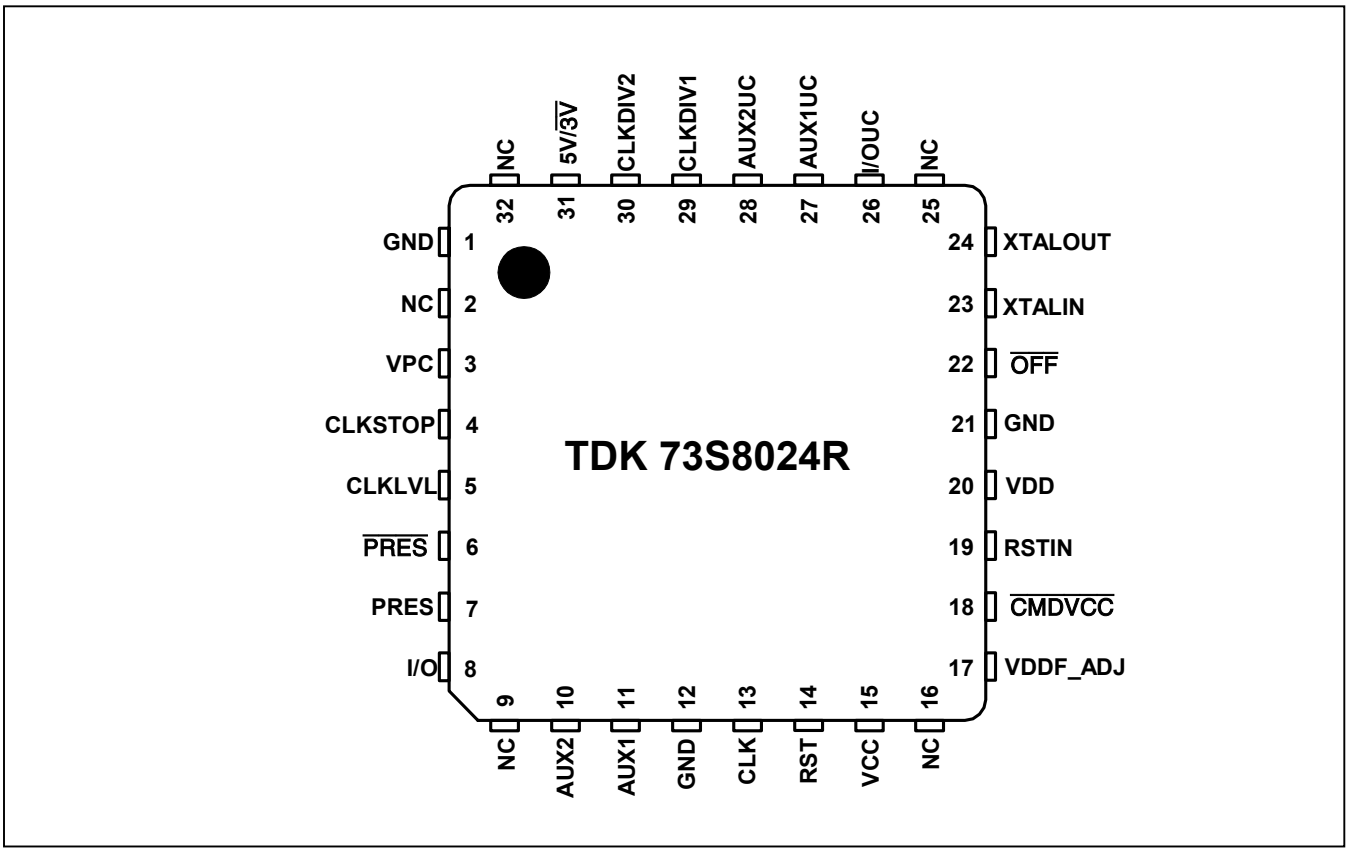


Figure 10: 32QFN 73S8024R Pin Out

MECHANICAL DRAWING

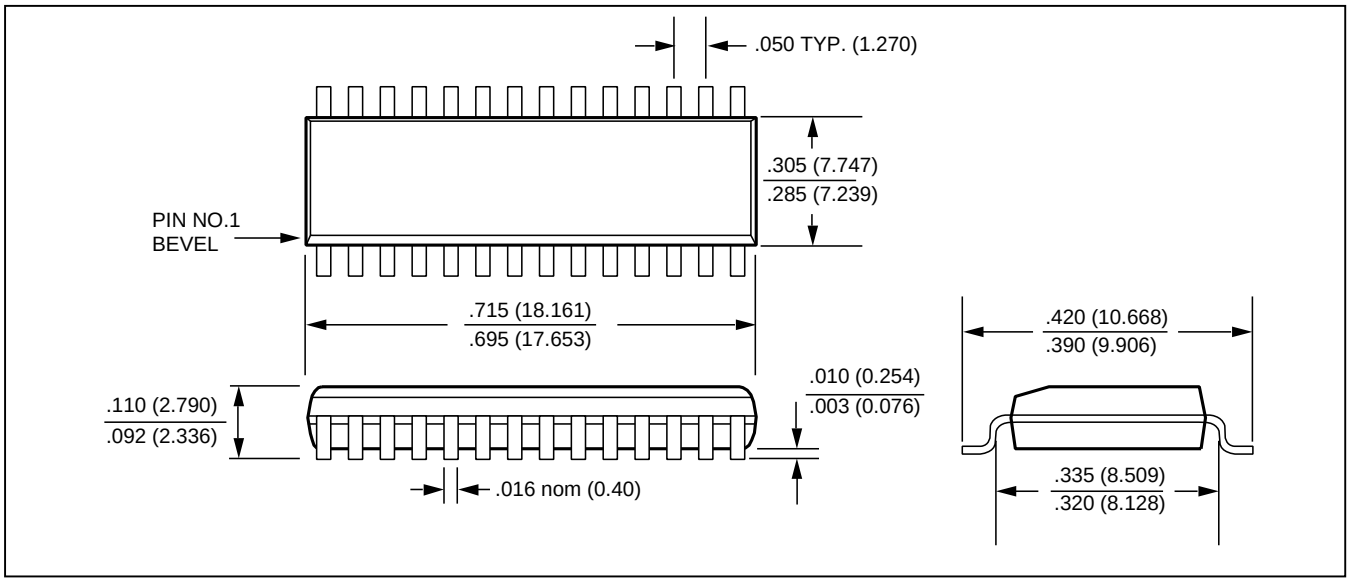


Figure 11: 28 Lead SO

PACKAGE PIN DESIGNATION (SO)

CAUTION: Use handling procedures necessary for a static sensitive component

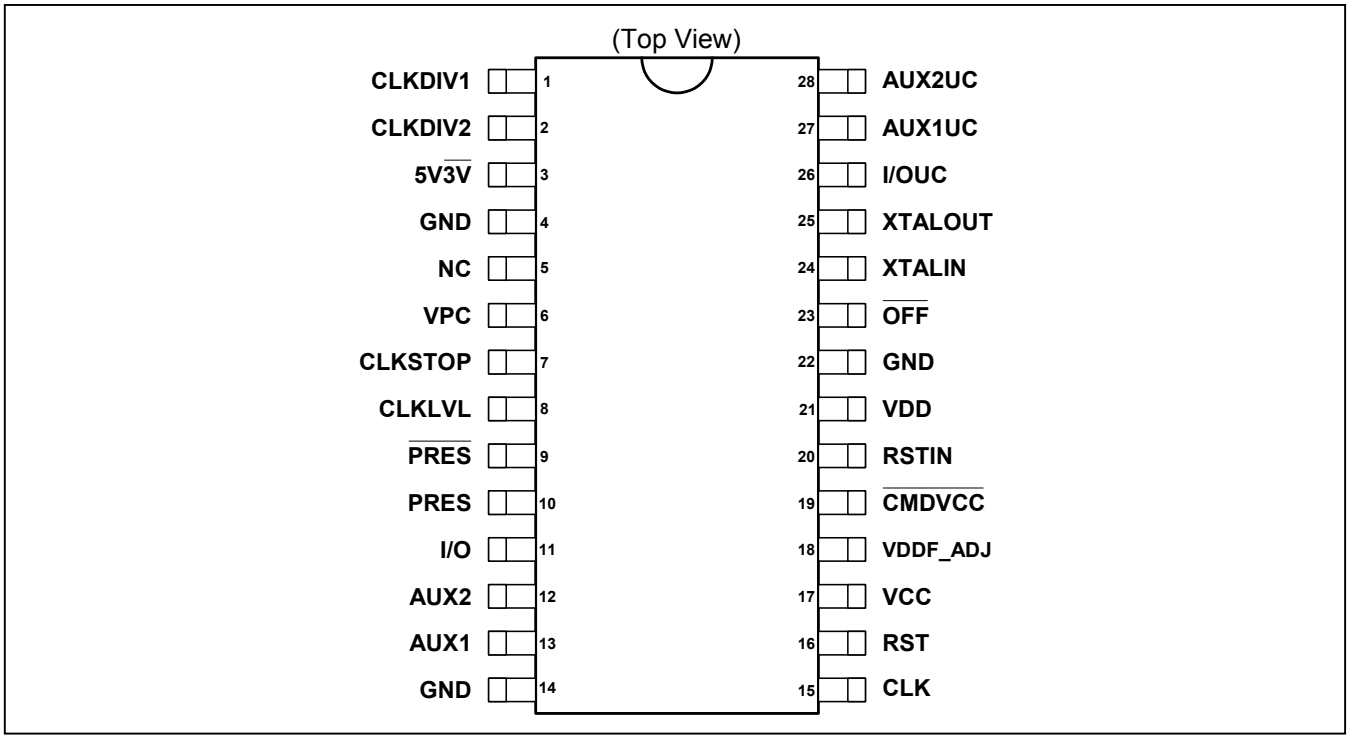


Figure 12: 28SO 73S8024R pin out

ORDERING INFORMATION

PART DESCRIPTION	ORDER NO.	PACKAGING MARK
73S8024R-SOL 28-pin SO	73S8024R-IL	73S8024R-IL
73S8024R-SOL 28-pin SO Tape / Reel	73S8024R-ILR	73S8024R-IL
73S8024R-SOL 28-pin Lead-Free SO	73S8024R-IL/F	73S8024R-IL
73S8024R-SOL 28-pin Lead-Free SO Tape / Reel	73S8024R-ILR/F	73S8024R-IL
73S8024R-QFN 32-pin QFN	73S8024R-IM	73S8024R
73S8024R-QFN 32-pin QFN Tape / Reel	73S8024R-IMR	73S8024R
73S8024R-QFN 32-pin Lead-Free QFN	73S8024R-IM/F	73S8024R
73S8024R-QFN 32-pin Lead-Free QFN Tape / Reel	73S8024R-IMR/F	73S8024R

TDK Semiconductor Corp. • 6440 Oak Canyon Rd. • Irvine, CA • 92618-5201
TEL (714) 508-8800 • FAX (714) 508-8877
http://www.tdksemiconductor.com