bq2204A

X4 SRAM Nonvolatile Controller Unit

Features

- Power monitoring and switching for 3-volt battery-backup applications
- Write-protect control
- 2-input decoder for control of up to 4 banks of SRAM
- 3-volt primary cell inputs
- Less than 10ns chip-enable propagation delay
- 5% or 10% supply operation

General Description

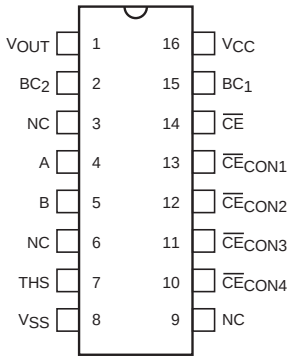
The CMOS bq2204A SRAM Nonvolatile Controller Unit provides all necessary functions for converting up to four banks of standard CMOS SRAM into nonvolatile read/write memory.

A precision comparator monitors the 5V V_{CC} input for an out-of-tolerance condition. When out-of-tolerance is detected, the four conditioned chip-enable outputs are forced inactive to write-protect up to four banks of SRAM.

During a power failure, the external SRAMs are switched from the V_{CC} supply to one of two 3V backup supplies. On a subsequent power-up, the SRAMs are write-protected until a power-valid condition exists.

During power-valid operation, a two-input decoder transparently selects one of up to four banks of SRAM.

Pin Connections



16-Pin Narrow DIP or SOIC

PN220401.eps

Pin Names

V_{OUT}	Supply output
BC_1–BC_2	3 volt primary backup cell inputs
THS	Threshold select input
$\overline{CE}$	chip-enable active low input
$\overline{CE}_{CON1}$–$\overline{CE}_{CON4}$	Conditioned chip-enable outputs
A–B	Decoder inputs
NC	No connect
V_{CC}	+5 volt supply input
V_{SS}	Ground

Functional Description

Up to four banks of CMOS static RAM can be battery-backed using the V_{OUT} and conditioned chip-enable output pins from the bq2204A. As V_{CC} slews down during a power failure, the conditioned chip-enable outputs $\overline{CE}_{CON1}$ through $\overline{CE}_{CON4}$ are forced inactive independent of the chip-enable input $\overline{CE}$.

This activity unconditionally write-protects the external SRAM as V_{CC} falls below an out-of-tolerance threshold V_{PFD}. V_{PFD} is selected by the threshold select input pin, THS. If THS is tied to V_{SS}, the power-fail detection occurs at 4.62V typical for 5% supply operation.

If THS is tied to V_{CC}, power-fail detection occurs at 4.37V typical for 10% supply operation. The THS pin must be tied to V_{SS} or V_{CC} for proper operation.

If a memory access is in process to any of the four external banks of SRAM during power-fail detection, that memory cycle continues to completion before the memory is write-protected. If the memory cycle is not terminated within time t_{WPT}, all four chip-enable outputs are unconditionally driven high, write-protecting the controlled SRAMs.

Dec. 1992 B

As the supply continues to fall past V_{PFD}, an internal switching device forces V_{OUT} to one of the two external backup energy sources. $\overline{CE}_{CON1}$ through $\overline{CE}_{CON4}$ are held high by the V_{OUT} energy source.

During power-up, V_{OUT} is switched back to the 5V supply as V_{CC} rises above the backup cell input voltage sourcing V_{OUT}. Outputs $\overline{CE}_{CON1}$ through $\overline{CE}_{CON4}$ are held inactive for time t_{CER} (120ms maximum) after the power supply has reached V_{PFD}, independent of the $\overline{CE}$ input, to allow for processor stabilization.

During power-valid operation, the $\overline{CE}$ input is passed through to one of the four $\overline{CE}_{CON}$ outputs with a propagation delay of less than 10ns. The $\overline{CE}$ input is output on one of the four $\overline{CE}_{CON}$ output pins depending on the level of the decode inputs at A and B as shown in the Truth Table.

The A and B inputs are usually tied to high-order address pins so that a large nonvolatile memory can be designed using lower-density memory devices. Nonvolatility and decoding are achieved by hardware hookup as shown in Figure 1.

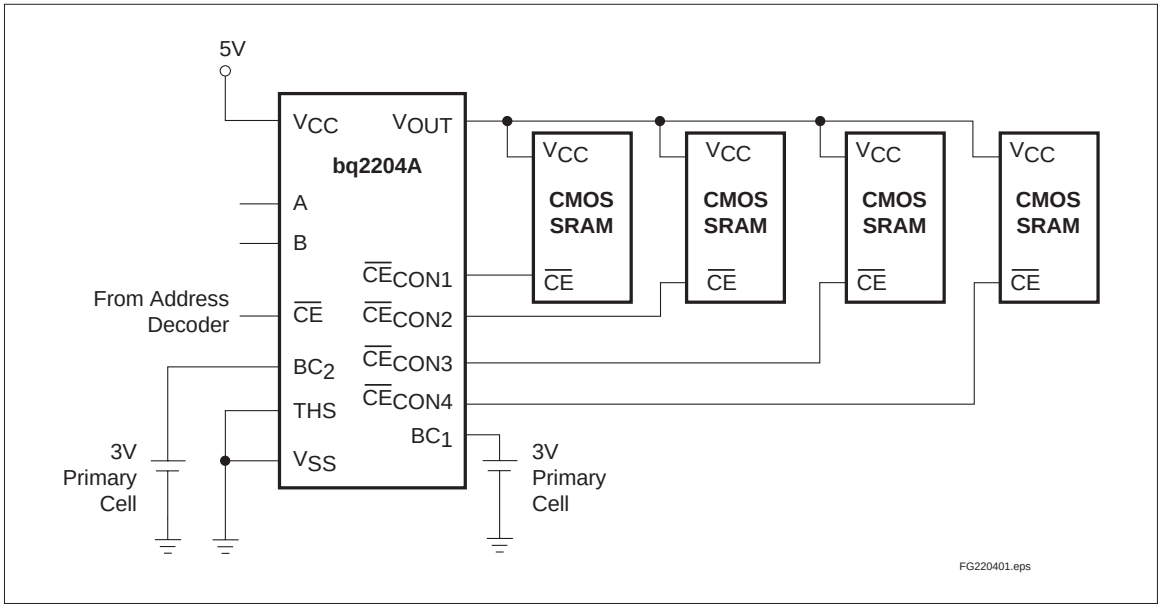


Figure 1. Hardware Hookup (5% Supply Operation)

Energy Cell Inputs—BC_1, BC_2

Two backup energy source inputs are provided on the bq2204A. The BC_1 and BC_2 inputs accept a 3V primary battery (non-rechargeable), typically some type of lithium chemistry. If no primary cell is to be used on either BC_1 or BC_2, the unused input should be tied to V_{SS}.

V_{CC} falling below V_{PFD} starts the comparison of BC_1 and BC_2. The BC input comparison continues until V_{CC} rises above V_{SO}. Power to V_{OUT} begins with BC_1 and switches to BC_2 only when V_{BC1} is less than V_{BC2} minus V_{BSO}. The controller alternates to the higher BC voltage only when the difference between the BC input voltages is greater than V_{BSO}. Alternating the backup batteries allows one-at-a-time battery replacement and efficient use of both backup batteries.

To prevent battery drain when there is no valid data to retain, V_{OUT} and $\overline{CE}_{CON1-4}$ are internally isolated from BC_1 and BC_2 by either of the following conditions:

- Initial connection of a battery to BC_1 or BC_2, or
- Presentation of an isolation signal on $\overline{CE}$.

A valid isolation signal requires $\overline{CE}$ low as V_{CC} crosses both V_{PFD} and V_{SO} during a power-down. See Figure 2. Between these two points in time, $\overline{CE}$ must be brought to the point of (0.48 to 0.52)*V_{CC} and held for at least 700ns. The isolation signal is invalid if $\overline{CE}$ exceeds 0.54*V_{CC} at any point between V_{CC} crossing V_{PFD} and V_{SO}.

The appropriate battery is connected to V_{OUT} and $\overline{CE}_{CON1–4}$ immediately on subsequent application and removal of V_{CC}.

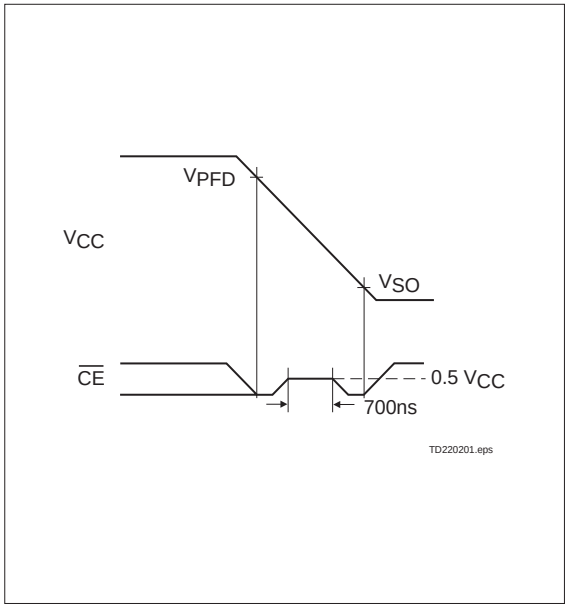


Figure 2. Battery Isolation Signal

Truth Table

Input			Output			
$\overline{CE}$	A	B	$\overline{CE}_{CON1}$	$\overline{CE}_{CON2}$	$\overline{CE}_{CON3}$	$\overline{CE}_{CON4}$
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	H	L	H	L	H	H
L	L	H	H	H	L	H
L	H	H	H	H	H	L

Absolute Maximum Ratings

Symbol	Parameter	Value	Unit	Conditions
V_{CC}	DC voltage applied on V_{CC} relative to V_{SS}	-0.3 to +7.0	V	
V_T	DC voltage applied on any pin excluding V_{CC} relative to V_{SS}	-0.3 to +7.0	V	$V_T \le V_{CC} + 0.3$
T_{OPR}	Operating temperature	0 to 70	°C	Commercial
		-40 to +85	°C	Industrial "N"
T_{STG}	Storage temperature	-55 to +125	°C	
T_{BIAS}	Temperature under bias	-40 to +85	°C	
T_{SOLDER}	Soldering temperature	260	°C	For 10 seconds
I_{OUT}	V_{OUT} current	200	mA	

Note: Permanent device damage may occur if **Absolute Maximum Ratings** are exceeded. Functional operation should be limited to the Recommended DC Operating Conditions detailed in this data sheet. Exposure to conditions beyond the operational limits for extended periods of time may affect device reliability.

Recommended DC Operating Conditions ($T_A = T_{OPR}$)

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Notes
V_{CC}	Supply voltage	4.75	5.0	5.5	V	THS = V_{SS}
		4.50	5.0	5.5	V	THS = V_{CC}
V_{SS}	Supply voltage	0	0	0	V	
V_{IL}	Input low voltage	-0.3	-	0.8	V	
V_{IH}	Input high voltage	2.2	-	V_{CC} + 0.3	V	
V_{BC1}, V_{BC2}	Backup cell voltage	2.0	-	4.0	V	$V_{CC} < V_{BC}$
THS	Threshold select	-0.3	-	V_{CC} + 0.3	V	

Note: Typical values indicate operation at T_A = 25°C, V_{CC} = 5V or V_{BC}.

DC Electrical Characteristics ($T_A = T_{OPR}$, V_{CC} = 5V ± 10%)

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Conditions/Notes
I_{LI}	Input leakage current	-	-	± 1	µA	$V_{IN} = V_{SS}$ to V_{CC}
V_{OH}	Output high voltage	2.4	-	-	V	I_{OH} = -2.0mA
V_{OHB}	V_{OH}, BC supply	V_{BC} - 0.3	-	-	V	$V_{BC} > V_{CC}$, I_{OH} = -10µA
V_{OL}	Output low voltage	-	-	0.4	V	I_{OL} = 4.0mA
I_{CC}	Operating supply current	-	3	6	mA	No load on outputs.
V_{PFD}	Power-fail detect voltage	4.55	4.62	4.75	V	THS = V_{SS}
		4.30	4.37	4.50	V	THS = V_{CC}
V_{SO}	Supply switch-over voltage	-	V_{BC}	-	V	
I_{CCDR}	Data-retention mode current	-	-	100	nA	V_{OUT} data-retention current to additional memory not included.
V_{BC}	Active backup cell voltage	-	V_{BC1}	-	V	$V_{BC1} > V_{BC2} + V_{BSO}$
		-	V_{BC2}	-	V	$V_{BC2} > V_{BC1} + V_{BSO}$
V_{BSO}	Battery switch-over voltage	0.25	0.4	0.6	V	
I_{OUT1}	V_{OUT} current	-	-	160	mA	$V_{OUT} > V_{CC}$ - 0.3V
I_{OUT2}	V_{OUT} current	-	100	-	µA	$V_{OUT} > V_{BC}$ - 0.2V

Note: Typical values indicate operation at T_A = 25°C, V_{CC} = 5V or V_{BC}.

Capacitance (T_A = 25°C, F = 1MHz, V_{CC} = 5.0V)

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Conditions
C_{IN}	Input capacitance	-	-	8	pF	Input voltage = 0V
C_{OUT}	Output capacitance	-	-	10	pF	Output voltage = 0V

Note: This parameter is sampled and not 100% tested.

AC Test Conditions

Parameter	Test Conditions
Input pulse levels	0V to 3.0V
Input rise and fall times	5ns
Input and output timing reference levels	1.5V (unless otherwise specified)

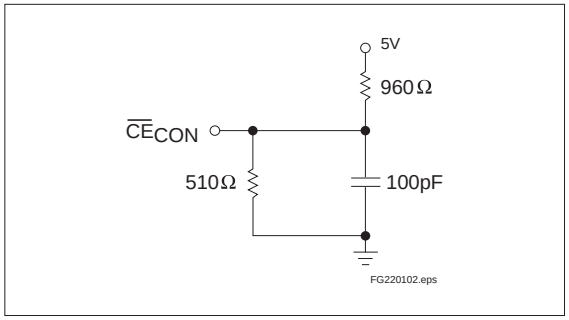


Figure 3. Output Load

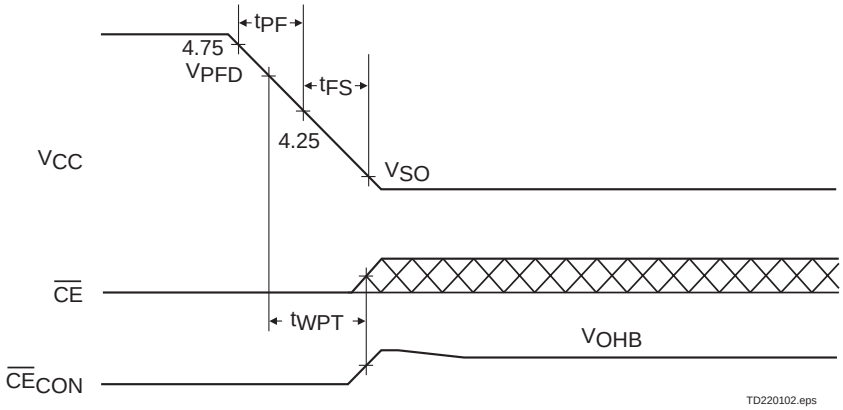
Power-Fail Control ($T_A = T_{OPR}$)

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Notes
t_{PF}	V_{CC} slew, 4.75V to 4.25V	300	-	-	µs	
t_{FS}	V_{CC} slew, 4.25V to V_{SO}	10	-	-	µs	
t_{PU}	V_{CC} slew, 4.25V to 4.75V	0	-	-	µs	
t_{CED}	chip-enable propagation delay	-	7	10	ns	
t_{AS}	A,B set up to $\overline{CE}$	0	-	-	ns	
t_{CER}	chip-enable recovery	40	80	120	ms	Time during which SRAM is write-protected after V_{CC} passes V_{PFD} on power-up.
t_{WPT}	Write-protect time	40	100	150	µs	Delay after V_{CC} slews down past V_{PFD} before SRAM is write-protected.

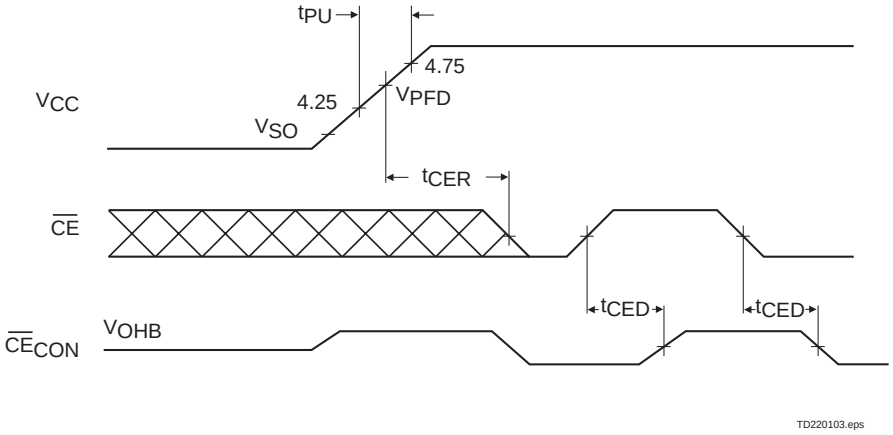
Note: Typical values indicate operation at T_A = 25°C, V_{CC} = 5V.

Caution: Negative undershoots below the absolute maximum rating of -0.3V in battery-backup mode may affect data integrity.

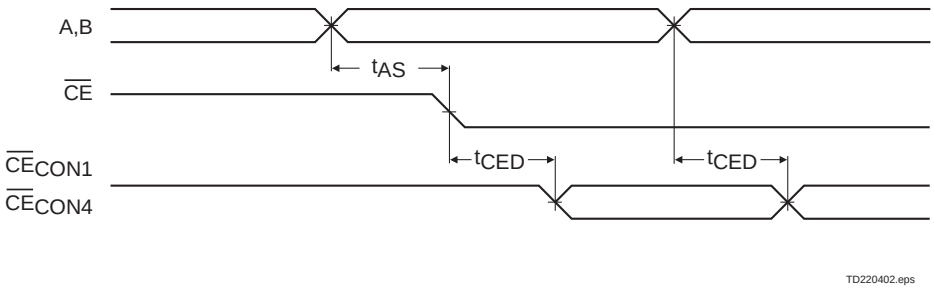
Power-Down Timing



Power-Up Timing

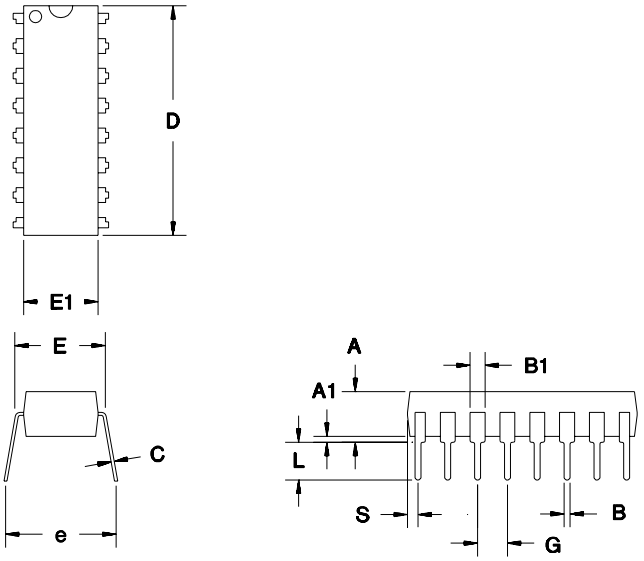


Address-Decode Timing



Dec. 1992 B

16-Pin DIP Narrow (PN)

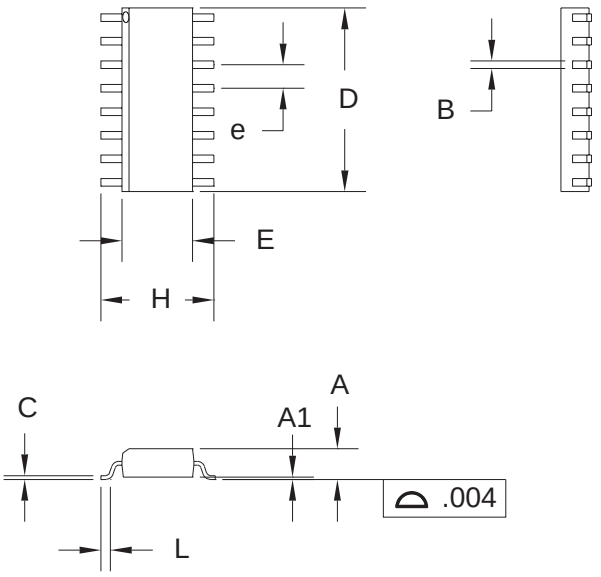


16-Pin PN (DIP Narrow)

Dimension	Minimum	Maximum
A	0.160	0.180
A1	0.015	0.040
B	0.015	0.022
B1	0.055	0.065
C	0.008	0.013
D	0.740	0.770
E	0.300	0.325
E1	0.230	0.280
e	0.300	0.370
G	0.090	0.110
L	0.115	0.150
S	0.020	0.040

All dimensions are in inches.

16-Pin SOIC Narrow (SN)



16-Pin SN (SOIC Narrow)

Dimension	Minimum	Maximum
A	0.060	0.070
A1	0.004	0.010
B	0.013	0.020
C	0.007	0.010
D	0.385	0.400
E	0.150	0.160
e	0.045	0.055
H	0.225	0.245
L	0.015	0.035

All dimensions are in inches.

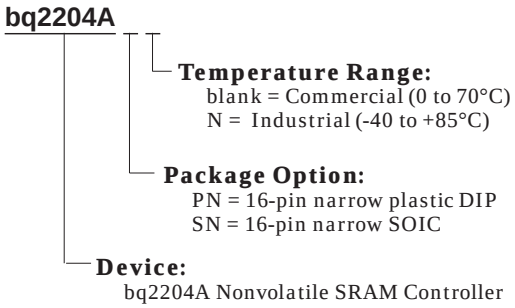
Dec. 1992 B

Data Sheet Revision History

Change No.	Page No.	Description of Change	Nature of Change
1	All	bq2204A replaces bq2204.	
1	1, 4–5	10% tolerance requires the THS pin to be tied to V_{CC}, not V_{OUT}.	
1	3	Energy cell input selection process alternates between BC_1 and BC_2.	

Note: Change 1 = Dec. 1992 changes from Sept. 1991

Ordering Information



IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.