

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

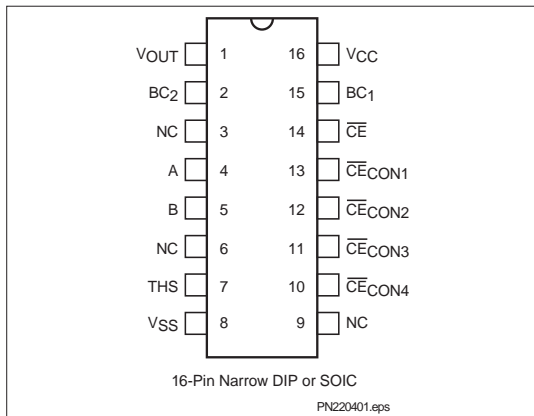
The CMOS bq2204A SRAM Nonvolatile Controller Unit provides all necessary functions for converting up to four banks of standard CMOS SRAM into nonvolatile read/write memory.

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



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.

bq2204A

As the supply continues to fall past $V_{PF\bar{D}}$, an internal switching device forces V_{OUT} to one of the two external backup energy sources. $\overline{CECON1}$ through $\overline{CECON4}$ 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 $\overline{CECON1}$ through $\overline{CECON4}$ are held inactive for time t_{CER} (120ms maximum) after the power supply has reached $V_{PF\bar{D}}$, 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{CECON} outputs with a propagation delay of less than 10ns. The \overline{CE} input is output on one of the four \overline{CECON} 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.

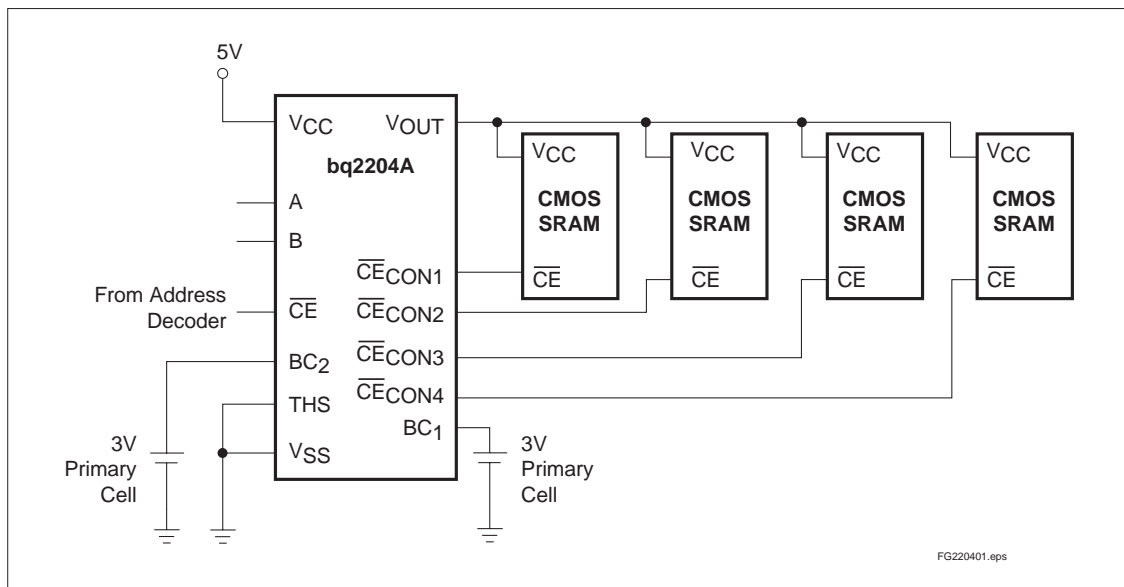


Figure 1. Hardware Hookup (5% Supply Operation)

Energy Cell Inputs—BC₁, BC₂

Two backup energy source inputs are provided on the bq2204A. The BC₁ and BC₂ inputs accept a 3V primary battery (non-rechargeable), typically some type of lithium chemistry. If no primary cell is to be used on either BC₁ or BC₂, the unused input should be tied to V_{SS}.

V_{CC} falling below V_{PFD} starts the comparison of BC₁ and BC₂. The BC input comparison continues until V_{CC} rises above V_{SO}. Power to V_{OUT} begins with BC₁ and switches to BC₂ 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 $\overline{\text{CE}}_{\text{CON1-4}}$ are internally isolated from BC₁ and BC₂ by either of the following conditions:

- Initial connection of a battery to BC₁ or BC₂, or
- Presentation of an isolation signal on $\overline{\text{CE}}$.

A valid isolation signal requires $\overline{\text{CE}}$ low as V_{CC} crosses both V_{PFD} and V_{SO} during a power-down. See Figure 2. Between these two points in time, $\overline{\text{CE}}$ 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 $\overline{\text{CE}}$ 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 $\overline{\text{CE}}_{\text{CON1-4}}$ immediately on subsequent application and removal of V_{CC}.

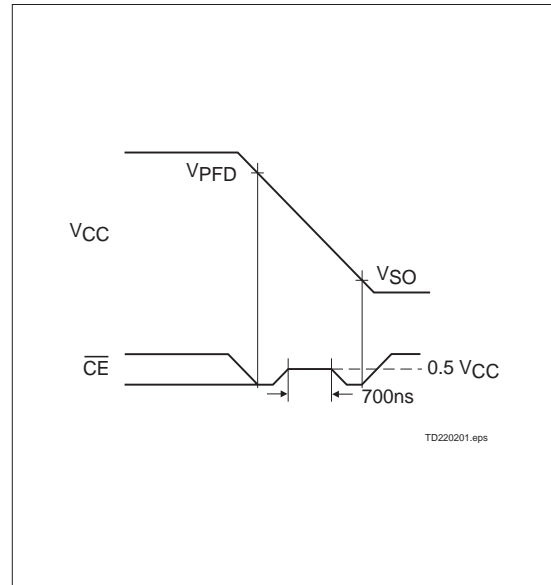


Figure 2. Battery Isolation Signal

Truth Table

Input			Output			
$\overline{\text{CE}}$	A	B	$\overline{\text{CE}}_{\text{CON1}}$	$\overline{\text{CE}}_{\text{CON2}}$	$\overline{\text{CE}}_{\text{CON3}}$	$\overline{\text{CE}}_{\text{CON4}}$
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

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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 ≤ 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 ($T_A = T_{OPR}$, $V_{CC} = 5V \pm 10\%$)

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 _{PF}	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 _B SO
		-	V _{BC2}	-	V	V _{BC2} > V _{BC1} + V _B SO
V _B SO	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 $T_A = 25^\circ\text{C}$, $V_{CC} = 5V$ or V_{BC} .

Capacitance ($T_A = 25^\circ\text{C}$, $F = 1\text{MHz}$, $V_{CC} = 5.0V$)

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.

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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)

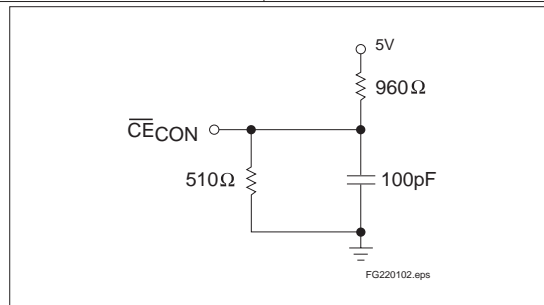


Figure 3. Output Load

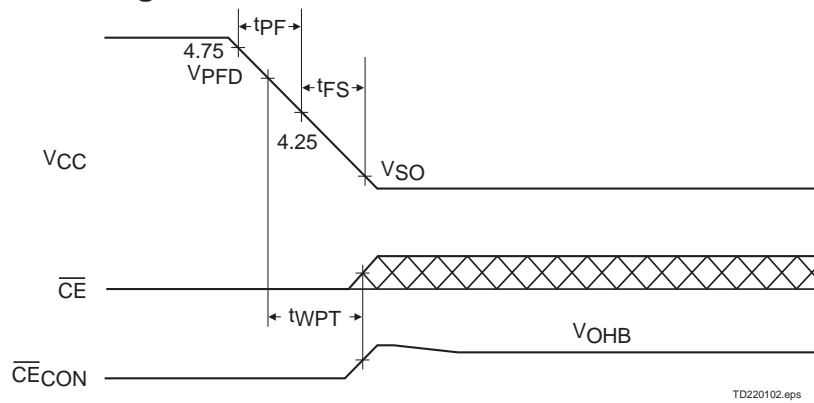
Power-Fail Control (TA = TOPR)

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Notes
tPF	VCC slew, 4.75V to 4.25V	300	-	-	μs	
tFS	VCC slew, 4.25V to VSO	10	-	-	μs	
tPU	VCC slew, 4.25V to 4.75V	0	-	-	μs	
tCED	chip-enable propagation delay	-	7	10	ns	
tAS	A,B set up to \overline{CE}	0	-	-	ns	
tCER	chip-enable recovery	40	80	120	ms	Time during which SRAM is write-protected after VCC passes V _{PF_D} on power-up.
tWPT	Write-protect time	40	100	150	μs	Delay after VCC slews down past V _{PF_D} before SRAM is write-protected.

Note: Typical values indicate operation at TA = 25°C, VCC = 5V.

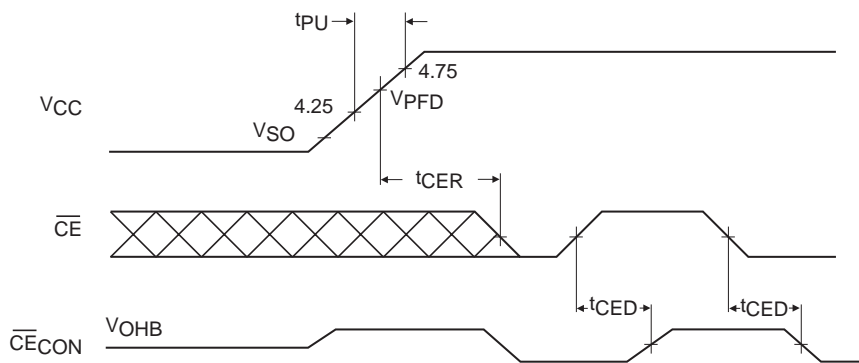
Caution: Negative undershoots below the absolute maximum rating of -0.3V in battery-backup mode may affect data integrity.

Power-Down Timing



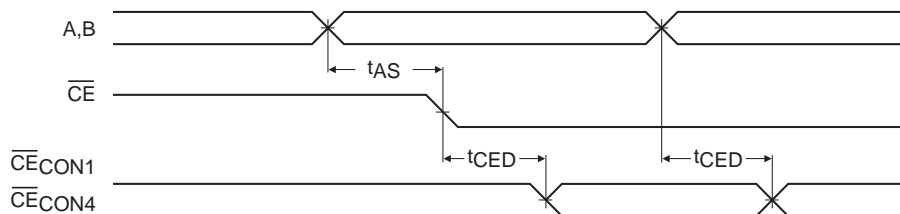
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Power-Up Timing



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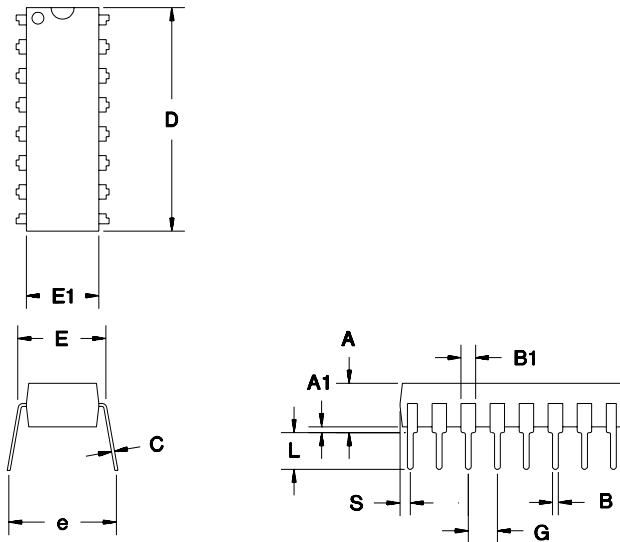
Address-Decode Timing



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16-Pin DIP Narrow (PN)

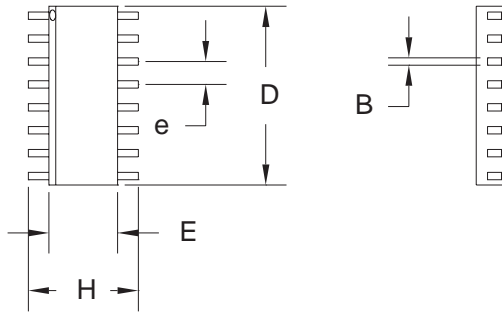


16-Pin PN (DIP Narrow)

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.

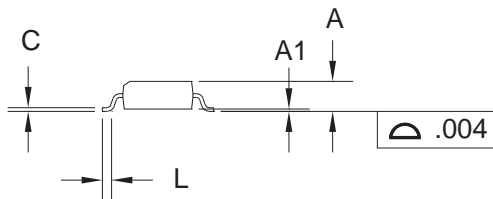
16-Pin SOIC Narrow (SN)



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.



bq2204A

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 VCC, not VOUT.	
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

bq2204A	
	Temperature Range: blank = Commercial (0 to 70°C) N = Industrial (-40 to +85°C)
	Package Option: PN = 16-pin narrow plastic DIP SN = 16-pin narrow SOIC
	Device: bq2204A Nonvolatile SRAM Controller

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