

SRAM NV Controller With Reset

Features

- Power monitoring and switching for nonvolatile control of SRAMs
- Write-protect control
- Input decoder allows control of up to 2 banks of SRAM
- 3-volt primary cell input
- 3-volt rechargeable battery input/output
- Reset output for system power-on reset
- Less than 10ns chip enable propagation delay
- 5% or 10% supply operation

General Description

The CMOS bq2202 SRAM Nonvolatile Controller With Reset provides all the necessary functions for converting one or two banks of standard CMOS SRAM into nonvolatile read/write memory.

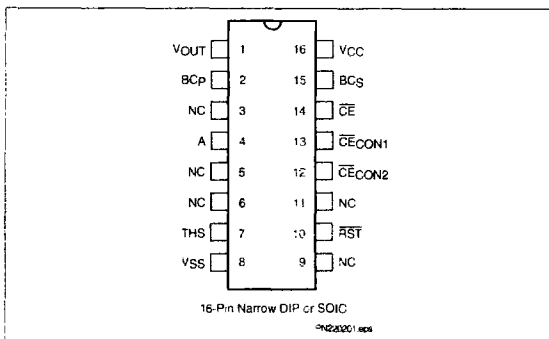
A precision comparator monitors the 5V VCC input for an out-of-tolerance condition. When out-of-tolerance is detected, the two conditioned chip-enable outputs are forced inactive to write-protect both banks of SRAM.

Power for the external SRAMs is switched from the VCC supply to the battery-backup supply as VCC decays. On a subsequent power-up, the VOUT supply is automatically switched from the backup supply to the VCC supply. The external SRAMs are write-protected until a power-valid condition exists. The reset output provides power-fail and power-on resets for the system.

During power-valid operation, the input decoder selects one of two banks of SRAM.

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Pin Connections



Pin Names

VOUT	Supply output
RST	Reset output
THS	Threshold select input
CE	Chip enable active low input
CECON1, CECON2	Conditioned chip enable outputs
A	Bank select input
BCP	3V backup supply input
BCS	3V rechargeable backup supply input/output
NC	No connect
VCC	+5 volt supply input
VSS	Ground

Functional Description

Two banks of CMOS static RAM can be battery-backed using the VOUT and conditioned chip-enable output pins from the bq2202. As the voltage input VCC slews down during a power failure, the two conditioned chip enable outputs, CECON1 and CECON2, are forced inactive independent of the chip enable input CE.

This activity unconditionally write-protects external SRAM as VCC falls to an out-of-tolerance threshold V_{PPD}. V_{PPD} 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 VCC, power-fail detection occurs at 4.37V typical for 10% supply operation. The THS pin must be tied to V_{SS} or VCC for proper operation.

If a memory access is in process to any of the two 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_{WP} (150μsec maximum), the two chip enable outputs are unconditionally driven high, write-protecting the controlled SRAMs.

As the supply continues to fall past V_{PF} , an internal switching device forces V_{OUT} to the internal backup energy source. $\overline{CECON1}$ and $\overline{CECON2}$ 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 $\overline{CECON1}$ and $\overline{CECON2}$ are held inactive for time t_{CER} (120ms maximum) after the power supply has reached V_{PF} , 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 two \overline{CECON} outputs with a propagation delay of less than 10ns. The \overline{CE} input is output on one of the two \overline{CECON} output pins; depending on the level of bank select input A, as shown in the Truth Table.

Bank select input A is usually tied to a high-order address pin 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.

The reset output (\overline{RST}) goes active within t_{PRD} (150 μ sec maximum) after V_{PF} , and remains active for a minimum of 40ms (120ms maximum) after power returns valid. The \overline{RST} output can be used as the power-on reset for a microprocessor. Access to the external RAM may begin when \overline{RST} returns inactive.

Energy Cell Inputs—BCP, BCS

Two backup energy source inputs are provided on the bq2202—a primary cell BCP and a secondary cell BCS. The primary cell input is designed to accept any 3V primary battery (non-rechargeable), typically some type of lithium chemistry. If a primary cell is not to be used, the BCP pin should be grounded. The secondary cell input BCS is designed to accept constant-voltage current-limited rechargeable cells.

During normal 5V power valid operation, 3.3V is output on the BCS pin and is current-limited internally.

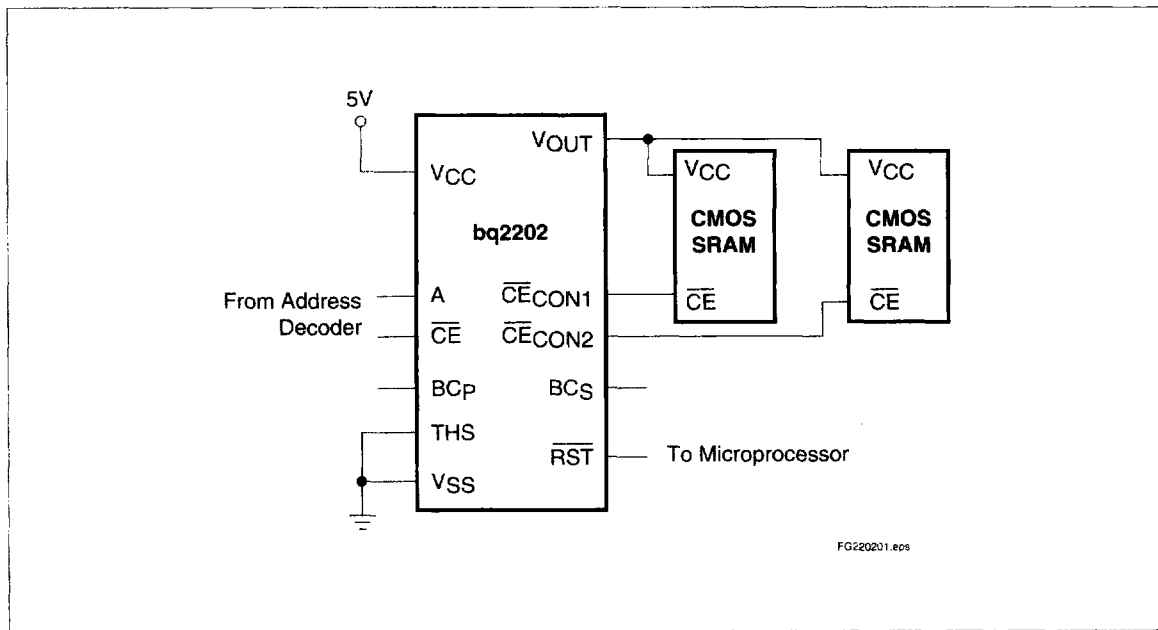


Figure 2. Hardware Hookup (5% Supply Operation)

If a secondary cell is not to be used, the BCS pin must be tied directly to VSS. If both inputs are used, during power failure the VOUT and $\overline{\text{CECON}}$ outputs are forced high by the secondary cell so long as it is greater than 2.5V. Only the secondary cell is loaded by the data retention current of the SRAM until the voltage at the BCS pin falls below 2.5V. When and if the voltage at BCS falls below 2.5V, an internal isolation switch automatically transfers the load from the secondary cell to the primary cell.

To prevent battery drain when there is no valid data to retain, VOUT, $\overline{\text{CECON1}}$, and $\overline{\text{CECON2}}$ are internally isolated from BCP and BCS by either:

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

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

The battery is connected to VOUT, $\overline{\text{CECON1}}$, and $\overline{\text{CECON2}}$ immediately on subsequent application and removal of VCC.

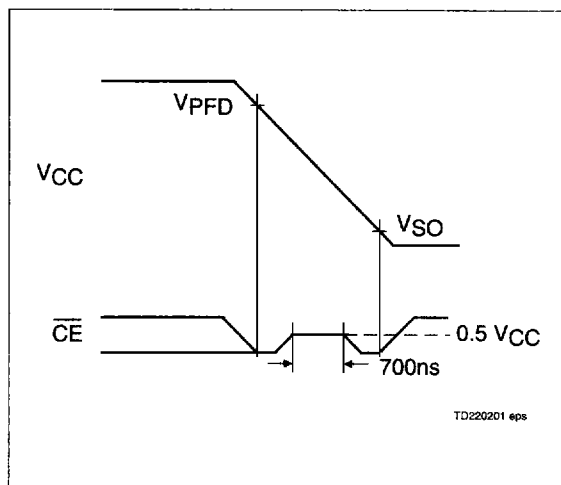


Figure 2. Battery Isolation Signal

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Truth Table

Input		Output	
$\overline{\text{CE}}$	A	$\overline{\text{CECON1}}$	$\overline{\text{CECON2}}$
H	X	H	H
L	L	L	H
L	H	H	L

Absolute Maximum Ratings

Symbol	Parameter	Value	Unit	Conditions
VCC	DC voltage applied on VCC relative to VSS	-0.3 to +7.0	V	
V _T	DC voltage applied on any pin excluding VCC relative to VSS	-0.3 to +7.0	V	V _T ≤ VCC + 0.3
TOPR	Operating temperature	0 to +70	°C	Commercial
		-40 to +85	°C	Industrial "N"
TSTG	Storage temperature	-55 to +125	°C	
TBIAS	Temperature under bias	-40 to +85	°C	
TSOLDER	Soldering temperature	260	°C	For 10 seconds
IOUT	VOUT 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 = TOPR)

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Notes
VCC	Supply voltage	4.75	5.0	5.5	V	THS = VSS
		4.50	5.0	5.5	V	THS = VCC
VBCP	Backup cell input voltage	2.0	-	4.0	V	VCC < VBC
VBCS		2.5	-	4.0		
VSS	Supply voltage	0	0	0	V	
VIL	Input low voltage	-0.3	-	0.8	V	
VIH	Input high voltage	2.2	-	VCC + 0.3	V	
THS	Threshold select	-0.3	-	VCC + 0.3	V	

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

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} , backup 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 V _{OUT} , $\overline{CECON1}$, and $\overline{CECON2}$
V _{PFDD}	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	No load on V _{OUT} , $\overline{CECON1}$, and $\overline{CECON2}$
V _{OUT1}	V _{OUT} voltage	V _{CC} - 0.2	-	-	V	V _{CC} > V _{BC} , I _{OUT} = 100mA
		V _{CC} - 0.3	-	-	V	V _{CC} > V _{BC} , I _{OUT} = 160mA
V _{OUT2}	V _{OUT} voltage	V _{BC} - 0.2	-	-	V	V _{CC} < V _{BC} , I _{OUT} = 100μA
V _{BC}	Active backup cell voltage	-	V _{B_{CS}}	-	V	V _{B_{CS}} > 2.5V
		-	V _{B_{CP}}	-	V	V _{B_{CS}} < 2.5V
R _{B_{CS}}	B _{CS} charge output internal resistance	500	1000	1750	Ω	V _{B_{CSO}} ≥ 3.0V
V _{B_{CSO}}	B _{CS} charge output voltage	3.0	3.3	3.6	V	V _{CC} > V _{PFDD} , \overline{RST} inactive, full charge or no load
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.

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)
Output load (including scope and jig)	See Figure 3

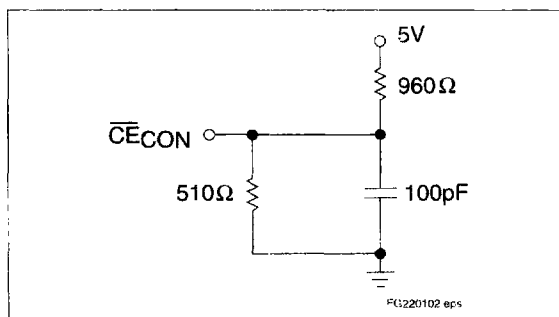


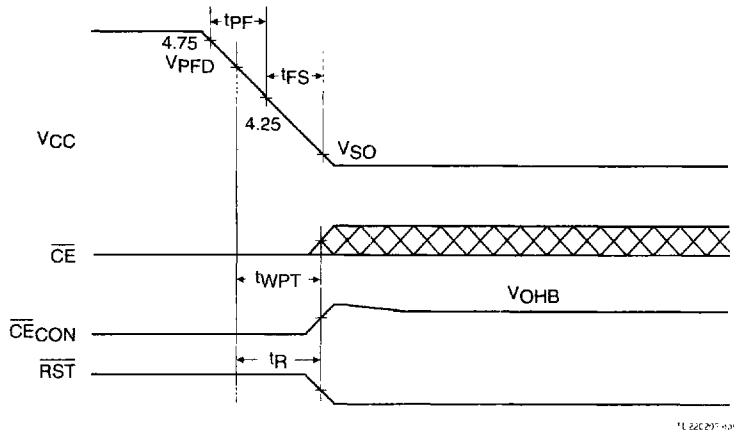
Figure 3. Output Load

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

Symbol	Parameter	Min.	Typ.	Max.	Unit	Conditions
t_{PF}	V_{CC} slew 4.75 to 4.25V	300	-	-	μs	
t_{FS}	V_{CC} slew 4.25 V to V_{SO}	10	-	-	μs	
t_{PU}	V_{CC} slew 4.25 to 4.75V	0	-	-	μs	
t_{CED}	Chip-enable propagation delay	-	7	10	ns	
t_{CER}	Chip-enable recovery time	t_{RR}	-	t_{RR}	ms	Time during which SRAM is write-protected after V_{CC} passes V_{PPD} on power-up
t_{RR}	V_{PPD} to \overline{RST} inactive	40	80	120	ms	Time, after V_{CC} becomes valid, before \overline{RST} is cleared
t_{AS}	Input A set up to \overline{CE}	0	-	-	ns	
t_{WPT}	Write-protect time	t_R	-	t_R	μs	Delay after V_{CC} slews down past V_{PPD} before SRAM is write-protected
t_R	V_{PPD} to \overline{RST} active	40	100	150	μs	Delay after V_{CC} slews down past V_{PPD} before \overline{RST} is active

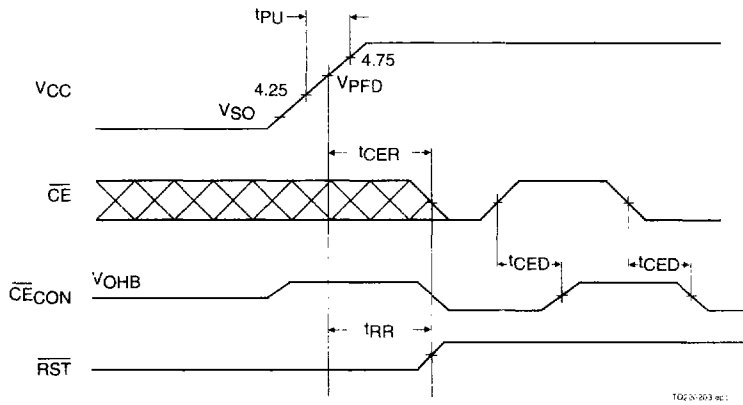
Note: Typical values indicate operation at $T_A = 25^\circ C$, $V_{CC} = 5V$.

Power-Down Timing

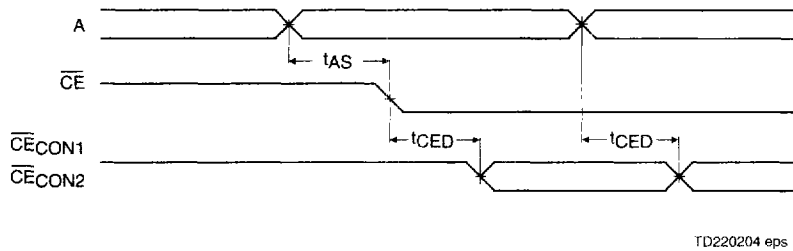


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Power-Up Timing



Address-Decode Timing



bq2202

Data Sheet Revision History

Change No.	Page No.	Description	Nature of Change
1	2	Deleted last sentence	Clarification
1	5	VBCSO—BCS charge output voltage	Was: 3.15 min, 3.3 typ, 3.45 max Is: 3.0 min, 3.3 typ, 3.6 max
2	5	Changed maximum charge output internal resistance (RBCS)	Was: 1500Ω Is: 1750Ω
3	1, 4, 5	10% supply operation	Was: THS tied to V _{OUT} Is: THS tied to V _{CC}

Note: Change 1 = Dec. 1992 B changes from Sept. 1991 A.
Change 2 = Nov. 1994 C changes from Dec. 1992 B.
Change 3 = Sept. 1997 D changes from Nov. 1994 C.

Ordering Information

bq2202

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:

bq2202 SRAM Nonvolatile Controller With Reset