HardStore 2K x 8 nvSRAM

Features

- High-performance CMOS nonvolatile static RAM 2048 x 8 bits
- 35 ns Access Times
- 20 ns Output Enable Access Times
- Hardware and Software STORE Initiation (STORE Cycle Time < 10 ms)
- Automatic STORE Timing
- 10^6 STORE cycles to EEPROM
- 100 years data retention in EEPROM
- Automatic RECALL on Power Up
- Hardware and Software RECALL Initiation (RECALL Cycle Time < 20 µs)
- Unlimited RECALL cycles from EEPROM
- Unlimited Read and Write to SRAM
- Single 5 V ± 10 % Operation
- Operating temperature ranges:
  0 to 70 °C
  -40 to 85 °C
- QS 9000 Quality Standard
- ESD characterization according MIL STD 883C M3015.7-HBM (classification see IC Code Numbers)
- Package: PLCC32

Description

The U630H16P has two separate modes of operation: SRAM mode and nonvolatile mode, determined by the state of the $\overline{NE}$ pin.

In SRAM mode, the memory operates as an ordinary static RAM. In nonvolatile operation, data is transferred in parallel from SRAM to EEPROM or from EEPROM to SRAM. In this mode SRAM functions are disabled.

The U630H16P is a fast static RAM (35 ns), with a nonvolatile electrically erasable PROM (EEPROM) element incorporated in each static memory cell. The SRAM can be read and written an unlimited number of times, while independent nonvolatile data resides in EEPROM. Data transfers from the SRAM to the EEPROM (the STORE operation), or from the EEPROM to the SRAM (the RECALL operation) are initiated through the state of the $\overline{NE}$ pin or through software sequences.

The U630H16P combines the high performance and ease of use of a fast SRAM with nonvolatile data integrity.

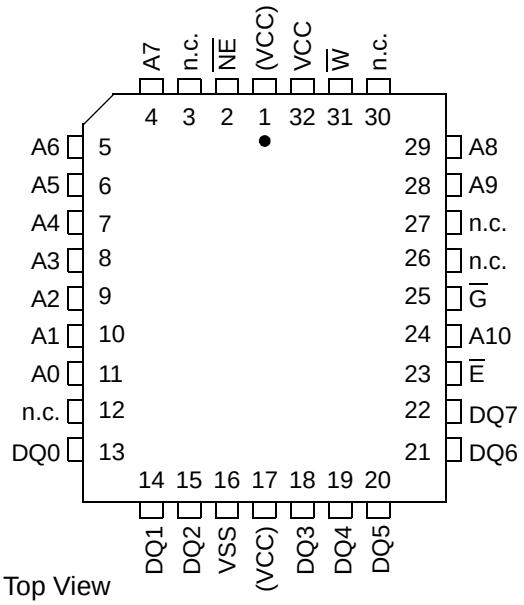
Once a STORE cycle is initiated, further input or output are disabled until the cycle is completed.

Because a sequence of addresses is used for STORE initiation, it is important that no other read or write accesses intervene in the sequence or the sequence will be aborted.

Internally, RECALL is a two step procedure. First, the SRAM data is cleared and second, the nonvolatile information is transferred into the SRAM cells.

The RECALL operation in no way alters the data in the EEPROM cells. The nonvolatile data can be recalled an unlimited number of times.

Pin Configuration

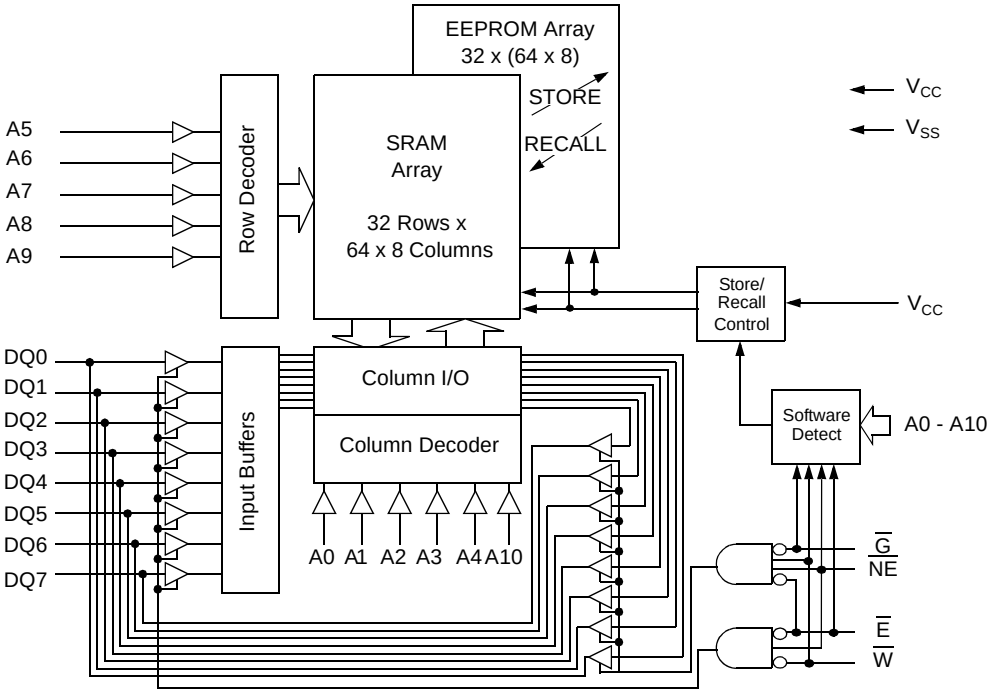


Top View

Pin Description

Signal Name	Signal Description
A0 - A10	Address Inputs
DQ0 - DQ7	Data In/Out
$\overline{E}$	Chip Enable
$\overline{G}$	Output Enable
$\overline{W}$	Write Enable
$\overline{NE}$	Nonvolatile Enable
VCC	Power Supply Voltage
VSS	Ground
n.c.	not connected
(VCC)	Power Supply Voltage (optional)

Block Diagram



Truth Table for SRAM Operations

Operating Mode	$\overline{E}$	$\overline{NE}$	$\overline{W}$	$\overline{G}$	DQ0 - DQ7
Standby/not selected	H	*	*	*	High-Z
Internal Read	L	H	H	H	High-Z
Read	L	H	H	L	Data Outputs Low-Z
Write	L	H	L	*	Data Inputs High-Z

* H or L

Characteristics

All voltages are referenced to V_{SS} = 0 V (ground).
All characteristics are valid in the power supply voltage range and in the operating temperature range specified.
Dynamic measurements are based on a rise and fall time of ≤ 5 ns, measured between 10 % and 90 % of V_I, as well as input levels of V_{IL} = 0 V and V_{IH} = 3 V. The timing reference level of all input and output signals is 1.5 V, with the exception of the t_{dis}-times and t_{en}-times, in which cases transition is measured ± 200 mV from steady-state voltage.

Absolute Maximum Ratings[a]		Symbol	Min.	Max.	Unit
Power Supply Voltage		V_{CC}	-0.5	7	V
Input Voltage		V_I	-0.3	V_{CC}+0.5	V
Output Voltage		V_O	-0.3	V_{CC}+0.5	V
Power Dissipation		P_D		1	W
Operating Temperature	C-Type K-Type	T_a	0 -40	70 85	°C °C
Storage Temperature		T_{stg}	-65	150	°C

a: Stresses greater than those listed under „Absolute Maximum Ratings“ may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at condition above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended Operating Conditions	Symbol	Conditions	Min.	Max.	Unit
Power Supply Voltage	V_{CC}		4.5	5.5	V
Input Low Voltage	V_{IL}	-2 V at Pulse Width 10 ns permitted	-0.3	0.8	V
Input High Voltage	V_{IH}		2.2	V_{CC}+0.3	V

DC Characteristics	Symbol	Conditions	C-Type		K-Type		Unit
			Min.	Max.	Min.	Max.	
Operating Supply Current[b]	I_{CC1}	V_{CC} = 5.5 V V_{IL} = 0.8 V V_{IH} = 2.2 V t_c = 35 ns		80		85	mA
Average Supply Current during STORE[c]	I_{CC2}	V_{CC} = 5.5 V $\overline{E}$ ≥ V_{CC}-0.2 V $\overline{W}$ ≥ V_{CC}-0.2 V V_{IL} ≤ 0.2 V V_{IH} ≥ V_{CC}-0.2 V		6		7	mA
Standby Supply Current[d] (Cycling TTL Input Levels)	$I_{CC(SB)1}$	V_{CC} = 5.5 V $\overline{E}$ ≥ V_{IH} t_c = 35 ns		23		27	mA
Average Supply Current at t_{cR} = 200 ns[b] (Cycling CMOS Input Levels)	I_{CC3}	V_{CC} = 5.5 V $\overline{W}$ ≥ V_{CC}-0.2 V V_{IL} ≤ 0.2 V V_{IH} ≥ V_{CC}-0.2 V		15		15	mA
Standby Supply Current[d] (Stable CMOS Input Levels)	$I_{CC(SB)}$	V_{CC} = 5.5 V $\overline{E}$ ≥ V_{CC}-0.2 V V_{IL} ≤ 0.2 V V_{IH} ≥ V_{CC}-0.2 V		1		1	mA

b: I_{CC1} and I_{CC3} are dependent on output loading and cycle rate. The specified values are obtained with outputs unloaded. The current I_{CC1} is measured for WRITE/READ - ratio of 1/2.

c: I_{CC2} is the average current required for the duration of the STORE cycle (STORE Cycle Time).

d: Bringing $\overline{E} \geq V_{IH}$ will not produce standby current levels until any nonvolatile cycle in progress has timed out. See MODE SELECTION table. The current $I_{CC(SB)1}$ is measured for WRITE/READ - ratio of 1/2.

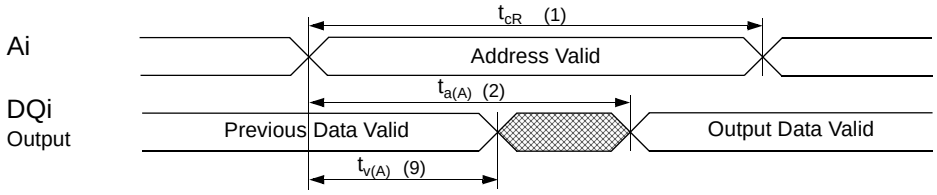
DC Characteristics	Symbol	Conditions	Min.	Max.	Unit
		V_{CC} = 4.5 V			
Output High Voltage	V_{OH}	I_{OH} =-4 mA	2.4		V
Output Low Voltage	V_{OL}	I_{OL} = 8 mA		0.4	V
		V_{CC} = 4.5 V			
Output High Current	I_{OH}	V_{OH} = 2.4 V		-4	mA
Output Low Current	I_{OL}	V_{OL} = 0.4 V	8		mA
Input Leakage Current		V_{CC} = 5.5 V			
High	I_{IH}	V_{IH} = 5.5 V		1	µA
Low	I_{IL}	V_{IL} = 0 V	-1		µA
Output Leakage Current		V_{CC} = 5.5 V			
High at Three-State- Output	I_{OHZ}	V_{OH} = 5.5 V		1	µA
Low at Three-State- Output	I_{OLZ}	V_{OL} = 0 V	-1		µA

SRAM Memory Operations

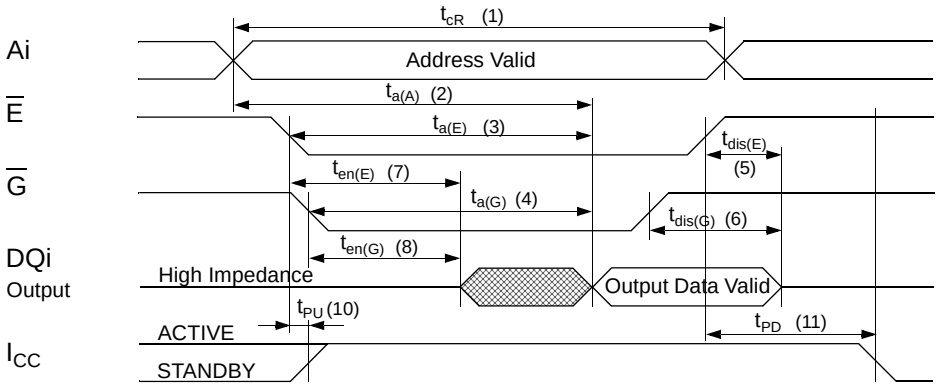
No.	Switching Characteristics Read Cycle	Symbol		35		Unit
		Alt.	IEC	Min.	Max.	
1	Read Cycle Time[f]	t_{AVAV}	t_{cR}	35		ns
2	Address Access Time to Data Valid[g]	t_{AVQV}	$t_{a(A)}$		35	ns
3	Chip Enable Access Time to Data Valid	t_{ELQV}	$t_{a(E)}$		35	ns
4	Output Enable Access Time to Data Valid	t_{GLQV}	$t_{a(G)}$		20	ns
5	$\overline{E}$ HIGH to Output in High-Z[h]	t_{EHQZ}	$t_{dis(E)}$		17	ns
6	$\overline{G}$ HIGH to Output in High-Z[h]	t_{GHQZ}	$t_{dis(G)}$		17	ns
7	$\overline{E}$ LOW to Output in Low-Z	t_{ELQX}	$t_{en(E)}$	5		ns
8	$\overline{G}$ LOW to Output in Low-Z	t_{GLQX}	$t_{en(G)}$	0		ns
9	Output Hold Time after Addr. Change[g]	t_{AXQX}	$t_{v(A)}$	3		ns
10	Chip Enable to Power Active[e]	t_{ELICCH}	t_{PU}	0		ns
11	Chip Disable to Power Standby[d, e]	t_{EHICCL}	t_{PD}		35	ns

e: Parameter guaranteed but not tested.
f: Device is continuously selected with $\overline{E}$ and $\overline{G}$ both LOW.
g: Address valid prior to or coincident with $\overline{E}$ transition LOW.
h: Measured ± 200 mV from steady state output voltage.

Read Cycle 1: Ai-controlled (during Read cycle: $\overline{E} = \overline{G} = V_{IL}$, $\overline{W} = \overline{NE} = V_{IH}$)[f]

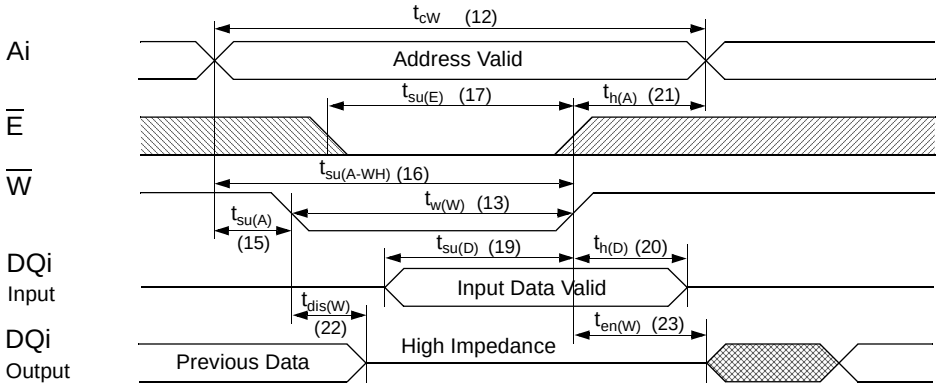


Read Cycle 2: $\overline{G}$-, $\overline{E}$-controlled (during Read cycle: $\overline{W} = \overline{NE} = V_{IH}$)[g]

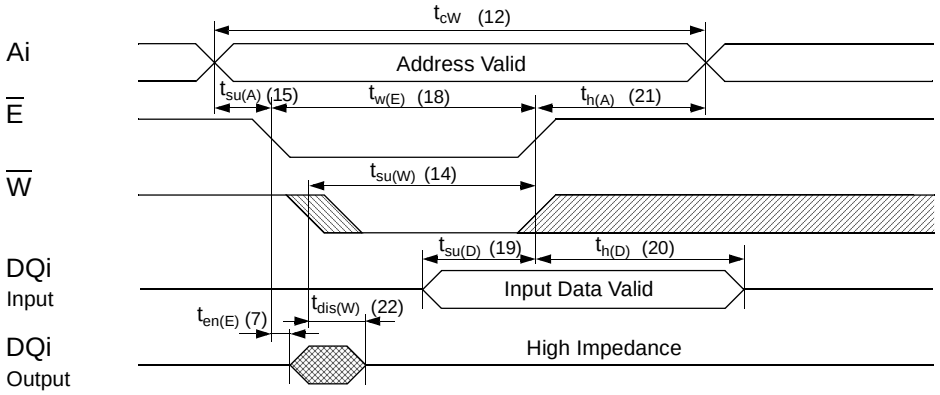


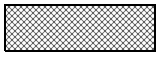
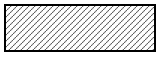
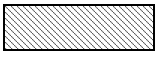
No.	Switching Characteristics Write Cycle	Symbol			35		Unit
		Alt. #1	Alt. #2	IEC	Min.	Max.	
12	Write Cycle Time	t_{AVAV}	t_{AVAV}	t_{cW}	35		ns
13	Write Pulse Width	t_{WLWH}		$t_{w(W)}$	30		ns
14	Write Pulse Width Setup Time		t_{WLEH}	$t_{su(W)}$	30		ns
15	Address Setup Time	t_{AVWL}	t_{AVEL}	$t_{su(A)}$	0		ns
16	Address Valid to End of Write	t_{AVWH}	t_{AVEH}	$t_{su(A-WH)}$	30		ns
17	Chip Enable Setup Time	t_{ELWH}		$t_{su(E)}$	30		ns
18	Chip Enable to End of Write		t_{ELEH}	$t_{w(E)}$	30		ns
19	Data Setup Time to End of Write	t_{DVWH}	t_{DVEH}	$t_{su(D)}$	18		ns
20	Data Hold Time after End of Write	t_{WHDX}	t_{EHDX}	$t_{h(D)}$	0		ns
21	Address Hold after End of Write	t_{WHAX}	t_{EHAX}	$t_{h(A)}$	0		ns
22	$\overline{W}$ LOW to Output in High-Z[h, i]	t_{WLQZ}		$t_{dis(W)}$		13	ns
23	$\overline{W}$ HIGH to Output in Low-Z	t_{WHQX}		$t_{en(W)}$	5		ns

Write Cycle #1: $\overline{W}$-controlled[j]



Write Cycle #2: $\overline{E}$-controlled[j]



undefined  L- to H-level  H- to L-level 

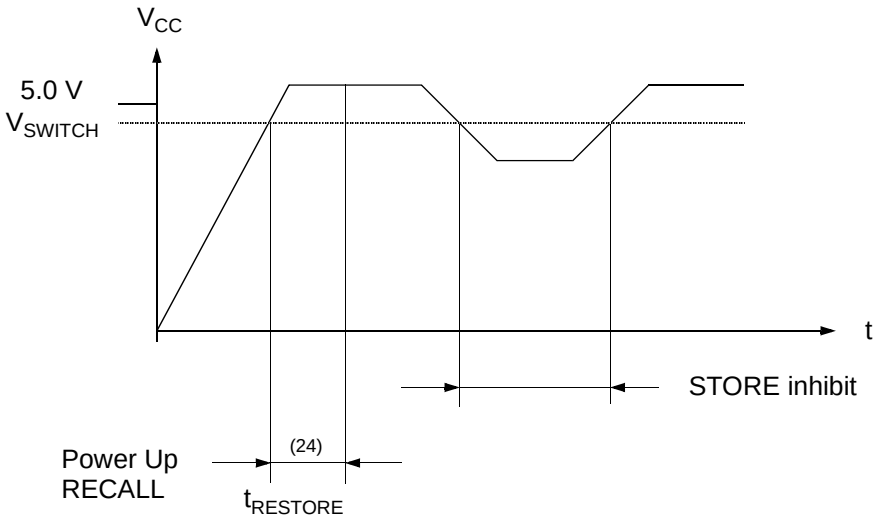
i: If $\overline{W}$ is LOW and when $\overline{E}$ goes LOW, the outputs remain in the high impedance state.
j: $\overline{E}$ or $\overline{W}$ and $\overline{NE}$ must be $\geq V_{IH}$ during address transitions.

Nonvolatile Memory Operations

No.	STORE Cycle Inhibit and Automatic Power Up RECALL	Symbol		Min.	Max.	Unit
		Alt.	IEC			
24	Power Up RECALL Duration[k, e]	$t_{RESTORE}$			650	µs
	Low Voltage Trigger Level	V_{SWITCH}		4.0	4.5	V

k: $t_{RESTORE}$ starts from the time V_{CC} rises above V_{SWITCH}.

STORE Cycle Inhibit and Automatic Power Up RECALL



Hardware Mode Selection

$\overline{E}$	$\overline{W}$	$\overline{G}$	$\overline{NE}$	Mode	Power	Notes
L	H	L	L	Nonvolatile RECALL	Active	l
L	L	H	L	Nonvolatile STORE	I_{CC2}	
L L	L H	L H	L *	No operation	Active	

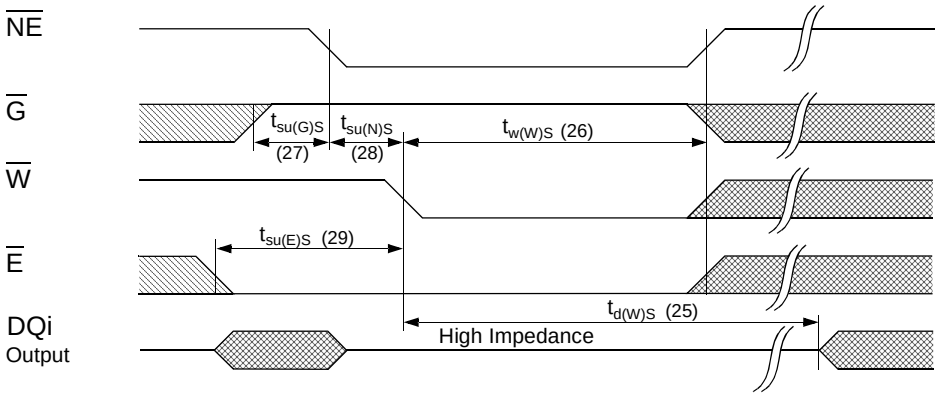
* H or L

l: An automatic RECALL also takes place at power up, starting when V_{CC} exceeds V_{SWITCH} and takes $t_{RESTORE}$. V_{CC} must not drop below V_{SWITCH} once it has been exceeded for the RECALL to function properly.

STORE Cycles

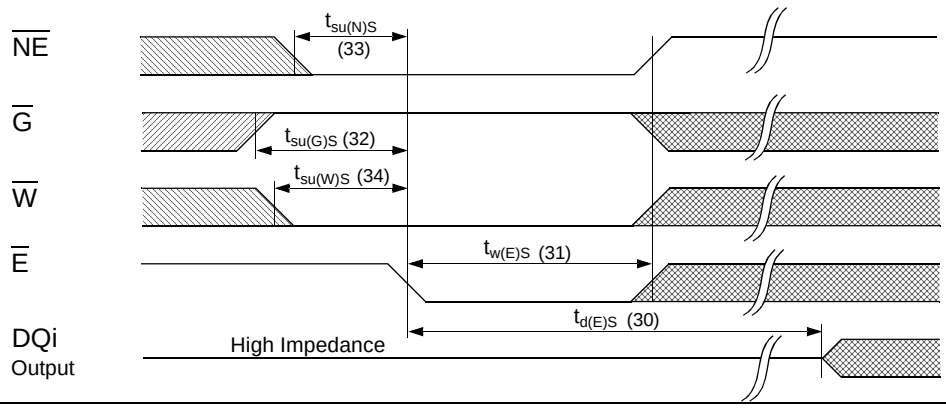
No.	STORE Cycle $\overline{W}$-controlled	Symbol		Min.	Max.	Unit
		Alt.	IEC			
25	STORE Cycle Time[m]	t_{WLQX}	$t_{d(W)S}$		10	ms
26	STORE Initiation Cycle Time[n]	t_{WLNH}	$t_{w(W)S}$	25		ns
27	Output Disable Setup to $\overline{NE}$ Fall	t_{GHNL}	$t_{su(G)S}$	5		ns
28	$\overline{NE}$ Setup	t_{NLWL}	$t_{su(N)S}$	5		ns
29	Chip Enable Setup	t_{ELWL}	$t_{su(E)S}$	5		ns

STORE Cycle: $\overline{W}$-controlled[o]



No.	STORE Cycle $\overline{E}$-controlled	Symbol		Min.	Max.	Unit
		Alt.	IEC			
30	STORE Cycle Time	t_{ELQXS}	$t_{d(E)S}$		10	ms
31	STORE Initiation Cycle Time	t_{ELNHS}	$t_{w(E)S}$	25		ns
32	Output Disable Setup to $\overline{E}$ Fall	t_{GHEL}	$t_{su(G)S}$	5		ns
33	$\overline{NE}$ Setup	t_{NLEL}	$t_{su(N)S}$	5		ns
34	Write Enable Setup	t_{WLEL}	$t_{su(W)S}$	5		ns

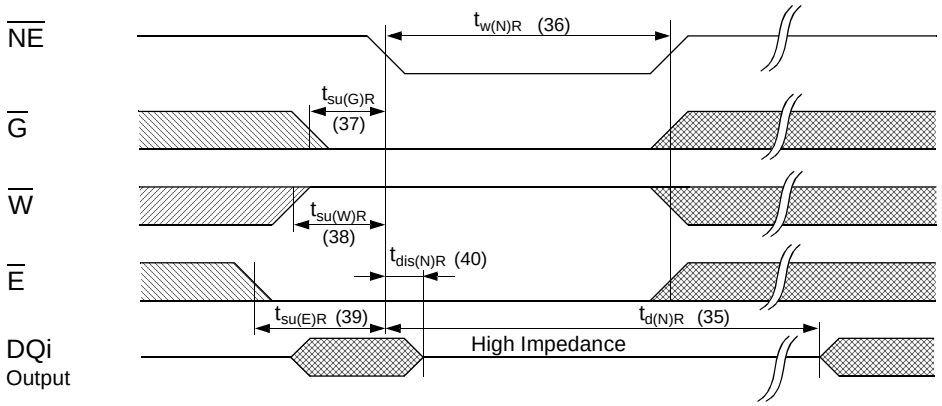
STORE Cycle: $\overline{E}$-controlled[o]



RECALL Cycles

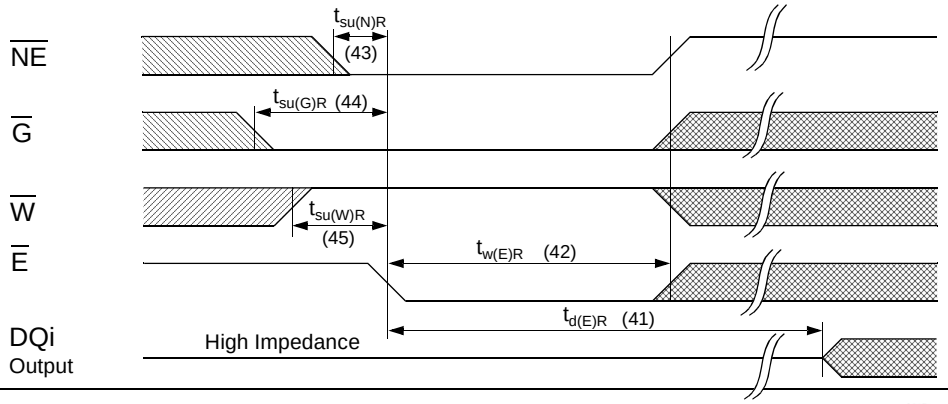
No.	RECALL Cycle $\overline{NE}$-controlled	Symbol		Min.	Max.	Unit
		Alt.	IEC			
35	RECALL Cycle Time[p]	t_{NLQX}	$t_{d(N)R}$		20	µs
36	RECALL Initiation Cycle Time[q]	t_{NLNH}	$t_{w(N)R}$	25		ns
37	Output Enable Setup	t_{GLNL}	$t_{su(G)R}$	5		ns
38	Write Enable Setup	t_{WHNL}	$t_{su(W)R}$	5		ns
39	Chip Enable Setup	t_{ELNL}	$t_{su(E)R}$	5		ns
40	$\overline{NE}$ Fall to Output Inactive	t_{NLQZ}	$t_{dis(N)R}$		25	ns

RECALL Cycle: $\overline{NE}$-controlled[o]



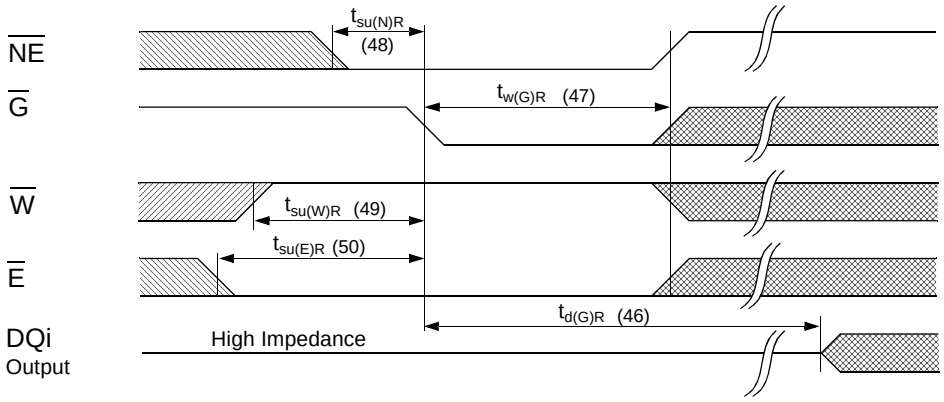
No.	RECALL Cycle $\overline{E}$-controlled	Symbol		Min.	Max.	Unit
		Alt.	IEC			
41	RECALL Cycle Time	t_{ELQXR}	$t_{d(E)R}$		20	µs
42	RECALL Initiation Cycle Time	t_{ELNHR}	$t_{w(E)R}$	25		ns
43	$\overline{NE}$ Setup	t_{NLEL}	$t_{su(N)R}$	5		ns
44	Output Enable Setup	t_{GLEL}	$t_{su(G)R}$	5		ns
45	Write Enable Setup	t_{WHEL}	$t_{su(W)R}$	5		ns

RECALL Cycle: $\overline{E}$-controlled[o]



No.	RECALL Cycle $\overline{G}$-controlled	Symbol		Min.	Max.	Unit
		Alt.	IEC			
46	RECALL Cycle Time	t_{GLQXR}	$t_{d(G)R}$		20	µs
47	RECALL Initiation Cycle Time	t_{GLNH}	$t_{w(G)R}$	25		ns
48	$\overline{NE}$ Setup	t_{NLGL}	$t_{su(N)R}$	5		ns
49	Write Enable Setup	t_{WHGL}	$t_{su(W)R}$	5		ns
50	Chip Enable Setup	t_{ELGL}	$t_{su(E)R}$	5		ns

RECALL Cycle: $\overline{G}$-controlled[o, r]



m: Measured with $\overline{W}$ and $\overline{NE}$ both returned HIGH, and $\overline{G}$ returned LOW. Note that STORE cycles are inhibited/aborted by $V_{CC} < V_{SWITCH}$ (STORE inhibit).

n: Once $t_{w(W)S}$ has been satisfied by $\overline{NE}$, $\overline{G}$, $\overline{W}$ and $\overline{E}$, the STORE cycle is completed automatically. Any of $\overline{NE}$, $\overline{G}$, $\overline{W}$ and $\overline{E}$ may be used to terminate the STORE initiation cycle.

o: If $\overline{E}$ is LOW for any period of time in which $\overline{W}$ is HIGH while $\overline{G}$ and $\overline{NE}$ are LOW, than a RECALL cycle may be initiated. For $\overline{E}$-controlled STORE during $t_{w(E)S}$ $\overline{W}$, $\overline{G}$, $\overline{NE}$ have to be static.

p: Measured with $\overline{W}$ and $\overline{NE}$ both HIGH, and $\overline{G}$ and $\overline{E}$ LOW.

q: Once $t_{w(N)R}$ has been satisfied by $\overline{NE}$, $\overline{G}$, $\overline{W}$ and $\overline{E}$, the RECALL cycle is completed automatically. Any of $\overline{NE}$, $\overline{G}$ or $\overline{E}$ may be used to terminate the RECALL initiation cycle.

r: If $\overline{W}$ is LOW at any point in which both $\overline{E}$ and $\overline{NE}$ are LOW and $\overline{G}$ is HIGH, than a STORE cycle will be initiated instead of a RECALL.

Software Mode Selection

$\overline{E}$	$\overline{W}$	A10 - A0 (hex)	Mode	I/O	Power	Notes
L	H	000	Read SRAM	Output Data	Active	s, t
		555	Read SRAM	Output Data		s, t
		2AA	Read SRAM	Output Data		s, t
		7FF	Read SRAM	Output Data		s, t
		0F0	Read SRAM	Output Data		s, t
		70F	Nonvolatile STORE	Output High Z	I_{CC2}	s
L	H	000	Read SRAM	Output Data	Active	s, t
		555	Read SRAM	Output Data		s, t
		2AA	Read SRAM	Output Data		s, t
		7FF	Read SRAM	Output Data		s, t
		0F0	Read SRAM	Output Data		s, t
		70E	Nonvolatile RECALL	Output High Z		s

s: The six consecutive addresses must be in order listed (000, 555, 2AA, 7FF, 0F0, 70F) for a Store cycle or (000, 555, 2AA, 7FF, 0F0, 70E) for a RECALL cycle. $\overline{W}$ must be high during all six consecutive cycles. See STORE cycle and RECALL cycle tables and diagrams for further details.
The following six-address sequence is used for testing purposes and should not be used: 000, 555, 2AA, 7FF, 0F0, 39C.

t: I/O state assumes that $\overline{G} \leq V_{IL}$. Activation of nonvolatile cycles does not depend on the state of $\overline{G}$.

No.	Software Controlled STORE/RECALL Cycle[s, u]	Symbol		25		35		45		Unit
		Alt.	IEC	Min.	Max.	Min.	Max.	Min.	Max.	
25	STORE/RECALL Initiation Time	t_{AVAV}	t_{cR}	25		35		45		ns
26	Chip Enable to Output Inactive[v]	t_{ELQZ}	$t_{dis(E)SR}$		600		600		600	ns
27	STORE Cycle Time[w]	t_{ELQXS}	$t_{d(E)S}$		10		10		10	ms
28	RECALL Cycle Time[l]	t_{ELQXR}	$t_{d(E)R}$		20		20		20	µs
29	Address Setup to Chip Enable[x]	t_{AVELN}	$t_{su(A)SR}$	0		0		0		ns
30	Chip Enable Pulse Width[x, y]	t_{ELEHN}	$t_{w(E)SR}$	20		25		35		ns
31	Chip Disable to Address Change[x]	t_{EHAXN}	$t_{h(A)SR}$	0		0		0		ns

u: The software sequence is clocked with $\overline{E}$ controlled READs.

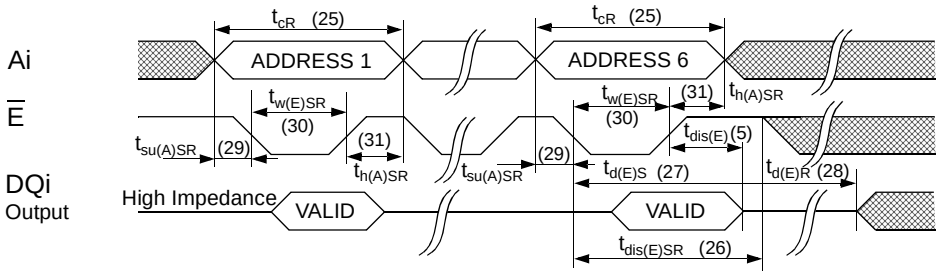
v: Once the software controlled STORE or RECALL cycle is initiated, it completes automatically, ignoring all inputs.

w: Note that STORE cycles (but not RECALL) are aborted by $V_{CC} < V_{SWITCH}$ (STORE inhibit).

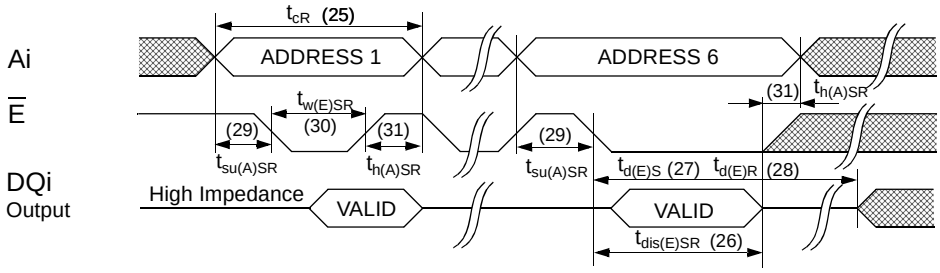
x: Noise on the $\overline{E}$ pin may trigger multiple READ cycles from the same address and abort the address sequence.

y: If the Chip Enable Pulse Width is less than $t_{a(E)}$ (see Read Cycle) but greater than or equal $t_{w(E)SR}$, than the data may not be valid at the end of the low pulse, however the STORE or RECALL will still be initiated.

Software Controlled STORE/RECALL Cycle[x, y, z, aa] ($\overline{E}$ = HIGH after STORE initiation)



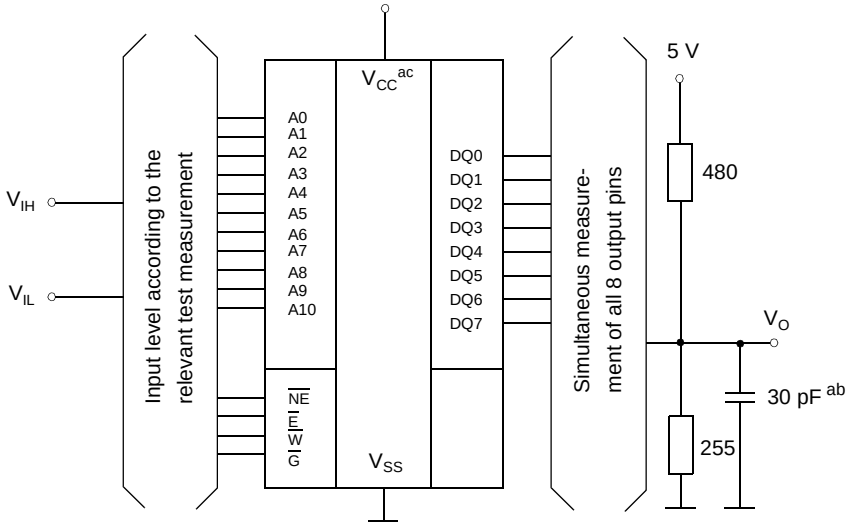
Software Controlled STORE/RECALL Cycle[x, y, z, aa] ($\overline{E}$ = LOW after STORE initiation)



z: $\overline{W}$ must be HIGH when $\overline{E}$ is LOW during the address sequence in order to initiate a nonvolatile cycle. $\overline{G}$ may be either HIGH or LOW throughout. Addresses 1 through 6 are found in the mode selection table. Address 6 determines whether the U630H16P performs a STOREor RECALL.

aa: $\overline{E}$ must be used to clock in the address sequence for the Software controlled STORE and RECALL cycles.

Test Configuration for Functional Check



ab: In measurement of t_{dis}-times and t_{en}-times the capacitance is 5 pF.

ac: Between V_{CC} and V_{SS} must be connected a high frequency bypass capacitor 0.1 µF to avoid disturbances.

Capacitance[e]	Conditions	Symbol	Min.	Max.	Unit
Input Capacitance	V_{CC} = 5.0 V V_I = V_{SS} f = 1 MHz T_a = 25 °C	C_I		8	pF
Output Capacitance		C_O		7	pF

All pins not under test must be connected with ground by capacitors.

Ordering Code

Example **U630H16 P C 35**

Type

ESD Class
blank > 2000 V

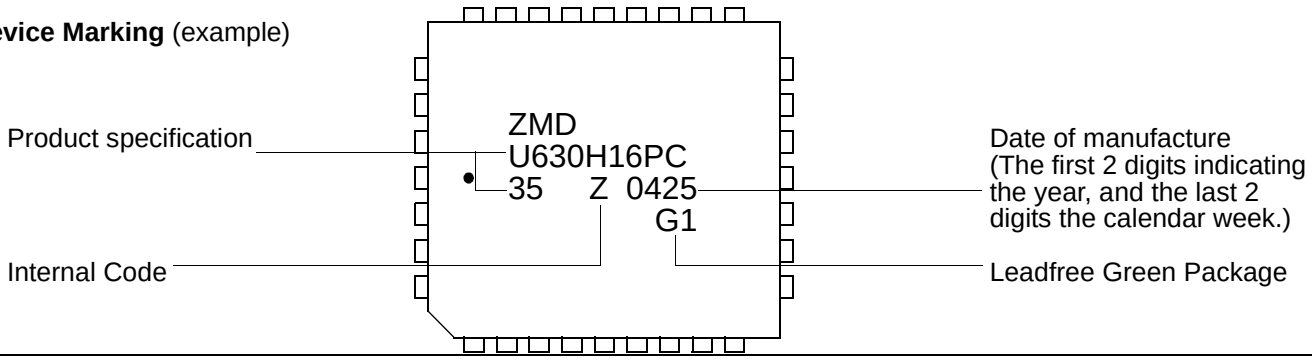
Package
P = PLCC32

Operating Temperature Range
C = 0 to 70 °C
K = -40 to 85 °C

Access Time
35 = 35 ns

Leadfree Option
blank = Standard Package
G1 = Leadfree Green Package [ad]

Device Marking (example)



Device Operation

The U630H16P has two separate modes of operation: SRAM mode and nonvolatile mode, determined by the state of the $\overline{NE}$ pin. In SRAM mode, the memory operates as a standard fast static RAM. In nonvolatile mode, data is transferred from SRAM to EEPROM (the STORE operation) or from EEPROM to SRAM (the RECALL operation). In this mode SRAM functions are disabled.

SRAM READ

The U630H16P performs a READ cycle whenever $\overline{E}$ and $\overline{G}$ are LOW while $\overline{W}$ and $\overline{NE}$ are HIGH. The address specified on pins A0 - A10 determines which of the 2048 data bytes will be accessed. When the READ is initiated by an address transition, the outputs will be valid after a delay of t_{cR}. If the READ is initiated by $\overline{E}$ or $\overline{G}$, the outputs will be valid at $t_{a(E)}$ or at $t_{a(G)}$, whichever is later. The data outputs will repeatedly respond to address changes within the t_{cR} access time without the need for transition on any control input pins, and will remain valid until another address change or until $\overline{E}$ or $\overline{G}$ is brought HIGH or $\overline{W}$ or $\overline{NE}$ is brought LOW.

SRAM WRITE

A WRITE cycle is performed whenever $\overline{E}$ and $\overline{W}$ are LOW and $\overline{NE}$ is HIGH. The address inputs must be stable prior to entering the WRITE cycle and must remain stable until either $\overline{E}$ or $\overline{W}$ goes HIGH at the end of the cycle. The data on pins DQ0 - 7 will be written into the memory if it is valid $t_{su(D)}$ before the end of a $\overline{W}$ controlled WRITE or $t_{su(D)}$ before the end of an $\overline{E}$ controlled WRITE.
It is recommended that $\overline{G}$ is kept HIGH during the entire WRITE cycle to avoid data bus contention on the common I/O lines. If $\overline{G}$ is left LOW, internal circuitry will turn off the output buffers $t_{dis(W)}$ after $\overline{W}$ goes LOW.

Noise Consideration

The U630H16P is a high speed memory and therefore must have a high frequency bypass capacitor of approximately 0.1 µF connected between V_{CC} and V_{SS} using leads and traces that are as short as possible. As with all high speed CMOS ICs, normal carefull routing of power, ground and signals will help prevent noise problems.

Hardware Nonvolatile STORE

A STORE cycle is performed when $\overline{NE}$, $\overline{E}$ and $\overline{W}$ are LOW while $\overline{G}$ is HIGH. While any sequence to achieve this state will initiate a STORE, only $\overline{W}$ initiation and $\overline{E}$ initiation are practical without risking an unintentional SRAM WRITE that would disturb SRAM data. During a STORE cycle, previous nonvolatile data is erased and the SRAM contents are then programmed into nonvolatile elements. Once a STORE cycle is initiated, further input and output is disabled and the DQ0 - 7 pins are tristated until the cycle is completed.
If $\overline{E}$ and $\overline{G}$ are LOW and $\overline{W}$ and $\overline{NE}$ are HIGH at the end of the cycle, a READ will be performed and the outputs will go active, indicating the end of the STORE.

Hardware Nonvolatile RECALL

A RECALL cycle is performed when $\overline{E}$, $\overline{G}$ and $\overline{NE}$ are LOW while $\overline{W}$ is HIGH. Like the STORE cycle, RECALL is initiated when the last of the three clock-signals goes to the RECALL state. Once initiated, the RECALL cycle will take „RECALL Cycle Time“ to complete, during which all inputs are ignored. When the RECALL completes, any READ or WRITE state on the input pins will take effect.
Internally, RECALL is a two step procedure. First, the SRAM data is cleared and second, the nonvolatile information is transferred into the SRAM cells. The RECALL in no way alters the data in the nonvolatile cells. The nonvolatile data can be recalled an unlimited number of times.
Like the STORE cycle, a transition must occur on some control pins to cause a RECALL, preventing inadvertend multi-triggering.

Software Nonvolatile STORE

The U630H16P software controlled STORE cycle is initiated by executing sequential READ cycles from six specific address locations. By relying on READ cycles only, the U630H16P implements nonvolatile operation while remaining compatible with standard 2K x 8 SRAMs. During the STORE cycle, an erase of the previous nonvolatile data is first performed, followed by parallel programming of all nonvolatile elements. Once a STORE cycle is initiated, further inputs and outputs are disabled until the cycle is completed.
Because a sequence of addresses is used for STORE initiation, it is important that no other READ or WRITE accesses intervene in the sequence or the sequence will be aborted and no STORE or RECALL will take place.
To initiate the STORE cycle the following READ sequence must be performed:

1.	Read address	000	(hex)	Valid READ
2.	Read address	555	(hex)	Valid READ
3.	Read address	2AA	(hex)	Valid READ
4.	Read address	7FF	(hex)	Valid READ
5.	Read address	0F0	(hex)	Valid READ
6.	Read address	70F	(hex)	Initiate STORE

Once the sixth address in the sequence has been entered, the STORE cycle will commence and the chip will be disabled. It is important that READ cycles and not WRITE cycles are used in the sequence. It is not necessary that $\overline{G}$ is LOW for the sequence to be valid. After the t_{STORE} cycle time has been fulfilled, the SRAM will again be activated for READ and WRITE operation.

Software Nonvolatile RECALL

A RECALL cycle of the EEPROM data into the SRAM is initiated with a sequence of READ operations in a manner similar to the STORE initiation. To initiate the RECALL cycle the following sequence of READ operations must be performed:

1.	Read address	000	(hex)	Valid READ
2.	Read address	555	(hex)	Valid READ
3.	Read address	2AA	(hex)	Valid READ
4.	Read address	7FF	(hex)	Valid READ
5.	Read address	0F0	(hex)	Valid READ
6.	Read address	70E	(hex)	Initiate RECALL

Internally, RECALL is a two step procedure. First, the SRAM data is cleared and second, the nonvolatile information is transferred into the SRAM cells. The RECALL operation in no way alters the data in the EEPROM cells. The nonvolatile data can be recalled an unlimited number of times.

Automatic Power Up RECALL

On power up, once V_{CC} exceeds the sense voltage of V_{SWITCH}, a RECALL cycle is automatically initiated. The voltage on the V_{CC} pin must not drop below V_{SWITCH} once it has risen above it in order for the RECALL to operate properly. Due to this automatic RECALL, SRAM operation cannot commence until $t_{RESTORE}$ after V_{CC} exceeds V_{SWITCH}. If the U630H16P is in a WRITE state at the end of power up RECALL, the SRAM data will be corrupted.
To help avoid this situation, a 10 KΩ resistor should be connected between $\overline{W}$ and system $V_{CC.}$

Hardware Protection

The U630H16P offers two levels of protection to suppress inadvertent STORE cycles. If the control signals ($\overline{E}$, $\overline{G}$, $\overline{W}$ and $\overline{NE}$) remain in the STORE condition at the end of a STORE cycle, a second STORE cycle will not be started. The STORE (or RECALL) will be initiated only after a transition on any one of these signals to the required state. In addition to multi-trigger protection, the U630H16P offers hardware protection through V_{CC} Sense. When $V_{CC} < V_{SWITCH}$ the externally initiated STORE operation will be inhibited.

Low Average Active Power

The U630H16P has been designed to draw significantly less power when $\overline{E}$ is LOW (chip enabled) but the access cycle time is longer than 55 ns.
When $\overline{E}$ is HIGH the chip consumes only standby current.
The overall average current drawn by the part depends on the following items:

1. CMOS or TTL input levels
2. the time during which the chip is disabled ($\overline{E}$ HIGH)
3. the cycle time for accesses ($\overline{E}$ LOW)
4. the ratio of READs to WRITEs
5. the operating temperature
6. the V_{CC} level

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Change record

Date/Rev	Name	Change
10.05.2004	Matthias Schniebel	initial release based on U630H16PA35 and U630H16 integrating software controlled Store / Recall (as U631H16)
31.3.2006	Troy Meester	changed to obsolete status
1.0	Simtek	Assigned Simtek Document Control Number