APPLICATIONS NOTE

Calculating the current consumption of an SDRAM

Part Type: SDRAM

Manufacturer: Maxwell Technologies

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PURPOSE: This application note describes the method used to calculate the current consumption of an SDRAM.

ABSTRACT: The average current consumption of an SDRAM is the sum of the operating currents divided by the total time.

(Operating current + Standby current + Burst Current + Refresh current) / Total Time

Current Consumption Formula:

Operating Current

[{ICC1 - iRASmin * (tRASmin - tRCmin) – iRPmin * (tRPmin / tRCmin)} * AN * (tRASmin + tRPmin)

Standby Current

+ iRAS * ΣtRAS + iRP + ΣtRP

Burst Operating Current

+ (iBST – iRAS) * (BN – AN) * tCK

Refresh Current

+ ICC5 * RN * tRC1min

Total Time

/ T]

Note: Definitions of the terms used in the above formula can be found in Table 2.

Example Calculation: This example uses Maxwell Technologies 256Mbit SDRAM, running at 100 MHZ. The operation used is a read-modify-write. The timing diagram in Figure 1. shows the SDRAM commands and their timing relationship used to perform the read-modify-write operation.

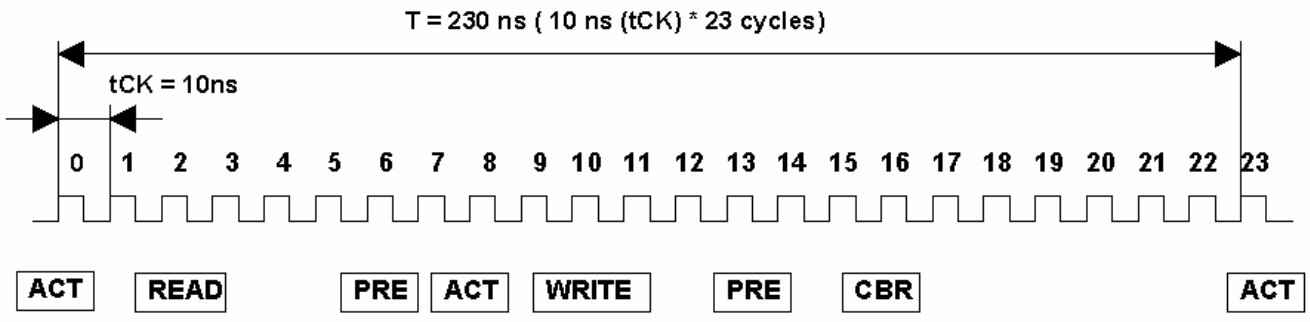

Figure 1. Timing Diagram

Table 2. Terms Required for current consumption calculations

Symble	Definition	Value
T	Total Time (ns)	230 ns
AN	Number of times an ACTIVE command is performed	2 times
BN	Number of times read/write is performed	8 times
RN	Number of times a CBR is issued	1 time
tCK	System Clock Cycle	10 ns
ΣtRAS	Time period between an ACTIVE command and a PRECHARGE command	120 ns
ΣRP	T - ΣtRAS – tRC1min * RN = (230ns – 120ns -67.5ns) * 1 time	42.5 ns
tRASmin	ACTIVE to PRECHARGE command period	50 ns
tRPmin	PRECHARGE to ACTIVE command period	20 ns
tRCmin	ACTIVE to ACTIVE command period	70 ns
tRC1min	REFRESH to REFRESH command period	70 ns
tCKmin	System clock cycle time	7.5 ns
ICC1	Operating Current (CAS* latency = 3)	115 mA
ICC2N	Standby Current in non-power down	20 mA
ICC3N	Active standby current in non-power down	30 mA
ICC4	Burst Operating Current	145 mA
ICC5	Refresh Current	220 mA
tCKi2N	tCK when ICC2 is measured	15 ns
tCKi3N	tCK when ICC3 is measured	15 ns
iRASmin	ICC3 * (tCKi3N / tCKmin) = 30 mA * (15 ns / 7.5 ns)	60 mA
iRPmin	ICC2N * (tCKi2N / tCKmin) = 2f0 mA * (15 ns / 7.5 ns)	40 mA
iRAS	ICC3N * (tCKi3N / tCK) = 30 mA * (15 ns / 10 ns)	45 mA
iRP	ICC2N * (tCKi2N / tCK) = 20 mA * (15 ns / 10 ns)	30 mA
iBST	ICC4 * (tCKmin / tCK) = 145 mA * (7.5 ns / 10 ns)	108.75 mA

Note: The values presented in Table 1 are taken from the Maxwell data sheet, 48SD1616, 256mbit SDRAM running at a clock frequency of 100MHz.

Current Consumption Calculations:

Average Operating Current Consumption Calculation

{ICC1 – iRASmin * (tRASmijn / tRCmin) – iRPmin *(tRPmin / tRCmin)} * AN (tRASmin + tRPmin)

= {115 mA – 60mA * (45 ns / 67.5 ns) – 40mA * (20 ns / 67.5 ns)} * 2 times * (45 ns + 20 ns)

= (115 mA – 60 mA*0.67 – 40 mA) * 2 times * 65 ns

= 115 mA – 40 mA – 12 mA * 130ns

= 63 mA * 130 ns

= 8190 mA –ns

Average Standby Current Consumption Calculation

iRAS * ΣtRAS + iRP * ΣtRP

= 45 mA * 120 ns + 30 mA * 42.5 ns

= 6675 mA-ns

Average Burst Operating Current Consumption Calculation

(iBST –iRAS) * (BN – AN) * tCK

= (108.75 mA – 45mA) * (8-2) times * 10 ns

= 3825 mA

Average Refresh Current Consumption Calculation

ICC5 * RN * tRC1min

= 220 mA * 1 time * 67.5 ns

= 14850 mA-ns

Average Current Consumption Calculation

(Operating Current + Standby Current + Burst Current + Refresh Current) / Total Time

(8190 mA-ns + 6675 mA-ns + 3825 mA-ns + 14850 mA-ns) / 230 ns

= **167.7 mA**

Conclusion: The average current consumption of an SDRAM is the sum of the operating currents divided by the total time. The average current consumption is dependent on the system clock frequency.

When analyzing the current consumption of an SDRAM, the designer must take into account the varies operations performed and calculate the average current consumption for each operation. Once this is complete the worst case current consumption can be determined.