

Energy Efficient Ethernet 1000BASE-T LPI Timing Parameters Update

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Objective

- Provide values for timing parameters presented in healey_02_0508 (1000BASE-T Low-Power Idle), considering the following primary objectives:
 - Support significant energy savings.
 - Enable implementation flexibility and feasibility.
 - Enable a reliable and fast wake procedure.



Comment Resolution

- Comments and discussion on grimwood_01_0708 led to the following additional more-detailed objectives:
 - Provide a quiet to refresh update ratio of 100:1 ($t_q/t_u : 1$) with fixed values for quiet duration, t_q , sleep duration, t_s , and update duration, t_u .
 - The update duration, t_u , is the time the PHY transmits during refresh to enable timing and coefficient update, where $t_r = t_u + t_w$. (t_w refers to tw_PHY)
 - To meet common timing and coefficient update objectives, let $t_s = t_u$.
 - Allow negotiation of t_w to allow vendors to drive toward higher-performing implementations, but initially bound the maximum t_w value to a “safe”, currently-implementable value.

EEE 1000BASE-T LPI Timing Parameters

Label	Parameter	Min	Typ	Max	Units
t_s	Time PHY transmits before going quiet	0.18	0.2	0.2	msec
t_m	Time PHY waits in the WAKE_TRAINING state before returning to normal operation	1.8	-	2.0	usec
t_q	Time PHY remains quiet before sending refresh	20	20	22	msec
t_u	Time PHY transmits during refresh to enable timing and coefficient update	0.18	0.2	0.2	msec
t_{wt}	Time PHY transmits to initiate wake-up in the link partner	TBD	-	TBD	usec
t_{w3}	Maximum transmitter stabilization time	-	-	TBD	usec
t_w	Maximum time to transition from low-power idle to normal operation	-	-	16	usec



Parameters labels and descriptions from healey_02_0508



Wake Time Analysis

(adapted from healey_02_0508)

① ② ③ ④ ⑤ ⑥ ⑦

$$t_w = (t_{w1} + t_p + t_{w2}) + t_{w3} + (t_1 + t_p + t_2) + t_{scr} + (t_1 + t_p + t_2) + t_{rcvr} + (t_1 + t_p + t_2)$$

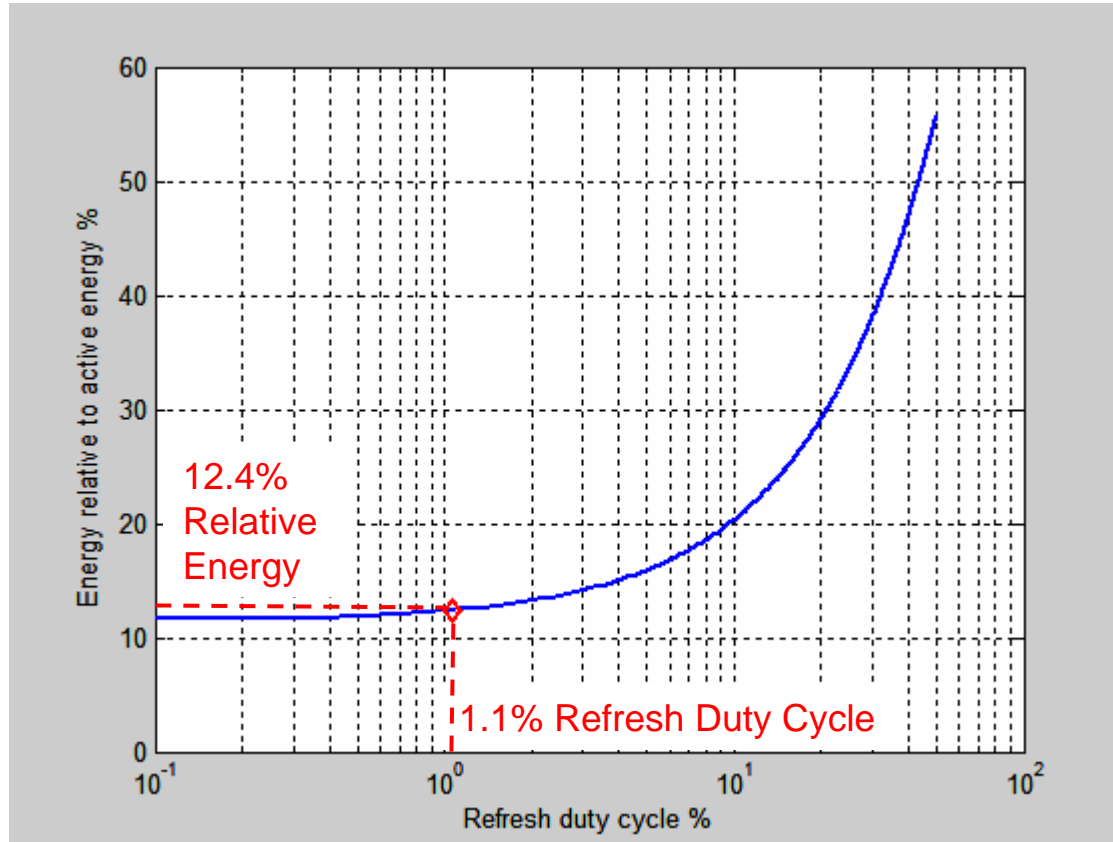
Label	healey_02_0508	grimwood_01_0708	Max	Units
①	1650	1600	1650	BT
②	5000	2000	5000	BT
③	878	860	878	BT
④	3000	3500	3500	BT
⑤	878	860	878	BT
⑥	1000	2500	2500	BT
⑦	878	860	878	BT
t_w	13284	12180	15284	BT



Use $t_w = 16$ usec as the maximum PHY wake time.



Energy Reduction During QRC for Proposed Timing Parameters



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Refresh duty cycle = $t_r / (t_q + t_r)$ [from healey_01_0308]

$t_q = 20$ msec, $t_u = 0.2$ msec, $t_w = 0.016$ msec

Conclusions

- Proposed timing parameters support 100:1 QRC energy savings mode.
- Refresh, sleep, and update time parameters support flexible, robust implementations.
- The 16 usec maximum wake time provides a reasonable bound; wake time negotiation will enable further performance optimization.
- Transmit stabilization time, T_{w3} , and power-on and energy detect time, T_{wt} , are important parameters that impact implementations and the overall wake time.
 - Values are TBD pending additional study.



Thank you!

