DP83848 - Single 10/100 Mb/s Ethernet Transceiver Energy Detect Mode

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1.0 Introduction

National's DP83848 10/100 Mb/s single port Physical Layer device offers low power consumption, including an intelligent power down state - Energy Detect mode. This application note explains the concept and the operation of the Energy Detect mode of the DP83848.

2.0 Concept of Energy Detect Mode

Energy Detect provides a mechanism to conserve power when the device is not connected to an active link partner. When no cable is present, or the cable is connected to a powered down partner, the DP83848 can be configured to automatically enter a low power state. Once activity resumes due to plugging a cable, or attempts by the far end to establish link, the DP83848 can automatically power up to a fully functioning state.

While in a low power Energy Detect state, the DP83848 reduces power consumption by disabling all receive circuitry except the Energy Detect circuitry. In addition the DP83848 will transmit signalling on the wire periodically as described in detail below.

3.0 Operation of Energy Detect Mode

Energy Detect operation consists of two states, a Normal Operation state and an Energy Detect state.

3.1 Normal Operation State

In a Normal Operation state, the Energy Detect logic relies on standard MDI (Medium Dependent Interface) activity (scrambled idles, link pulses, packets) to maintain a power up state. When Energy Detect is enabled, the DP83848 will transition to an Energy Detect state if the Energy Detect logic detects an absence of MDI activity.

3.2 Energy Detect Operation

When enabled and in an Energy Dectect state, Energy Detect provides continuous monitoring via dedicated low power circuits. During this time, registers can be accessed through the serial management interface (MDC/MDIO). To conserve power, most chip functionality remains powered down. In a Energy Detect state, the DP83848 alternates between two functions: monitoring the wire to detect activity, and transmitting pulses on the wire.

The DP83848 monitors both Transmit and Receive cable pairs for activity. When an appropriate amount of activity is detected, the device will indicate this condition in the Energy Detect Control Register (EDCR). In addition, the device can be programmed to interrupt the system and/or automatically transition to a Normal Operation Mode. The amount of activity required to trigger an Energy Detect event is controllable via the thresholds in the EDCR register. Moreover, the device can report error conditions for the Energy Detect circuit. This can occur if the Energy Detect circuit detects simultaneous signalling of opposite polarity on the transmit and receive pairs (e.g. a "+1" is seen on the transmit pair while a "-1" is seen on the receiver pair). This signalling is invalid and should never occur.

If a device and its link partner are both in an Energy Detect low power state, each device looks for receive activity to allow it to power up. To resolve this condition, the DP83848 periodically transmits pulses to its partner, thereby allowing the partner to power up and initiate normal transmit activity. While the pulses are similar to link pulses, their spacing is insufficient to maintain 10Mb/s link with a partner.

The exact spacing of the pulses contains a random component. Since the receiver is disabled while transmitting pulses, two stations with an identical transmit sequence could result in an inability to recover from an Energy Detect Mode. The random component of the transmit sequence prevents this condition.

4.0 Configuration of Energy Detect Mode

4.1 Enabling Energy Detect Mode

Energy detect is disabled by default and must be enabled by MDIO register access. Note that the recommended Energy Detect Configuration is different than the default value in the EDCR register. To enable automatic power up and down using Energy Detect, the EDCR register should be written with a value of 0xE81f.

4.2 Register Definitions

Basic control and status of the Energy Detect function is available through the Energy Detect Control Register (EDCR, see *Table 1*). In addition to the basic enable and status, the EDCR register provides the following controls:

Automatic Power Up and Power Down. The device can be programmed to allow automatic state transitions based on Energy Detect events.

Manual Power Up and Power Down. The manual power up and down mechanism allows software controlled state transitions.

Transmit Burst Operation. The Energy Detect transmitter can send pulses in bursts of 4 or as a single pulse at a time. The recommended configuration is to disable transmit bursting by setting ED_BURST_DIS to 1.

Error Count Threshold. In the unlikely event that signalling is seen as both positive and negative at the same time, an energy error will be detected. The error count threshold sets the number of errors required to trigger an Energy Detect event. When the threshold is reached, an interrupt will be signalled (if enabled), but no other action will be taken.

Data Count Threshold. The data count threshold determines the number of valid events required to initiate powering up from a low power state. For robust operation, the data count threshold should be set to its maximum value (0xf).

4.0 Configuration of Energy Detect Mode (Continued)

TABLE 1. Energy Detect Control (EDCR), address 0x1D

Bit	Bit Name	Default	Description
15	ED_EN	0, RW	**Energy Detect Enable:** Allow Energy Detect Mode
14	ED_AUTO_UP	1, RW	**Energy Detect Automatic Power Up**: Automatically begin power up sequence when Energy Detect Data Threshold value (EDCR[3:0]) is reached. Alternately, device could be powered up manually using the ED_MAN bit (EDCR[12]).
13	ED_AUTO_DOWN	1, RW	**Energy Detect Automatic Power Down:** Automatically begin power down sequence when no energy is detected. Alternately, device could be powered down manually using the ED_MAN bit (EDCR[12]).
12	ED_RW/SCMAN 0		**Energy Detect Manual Power Up/Down**: Begin power up/down sequence when this bit is asserted. When set, the Energy Detect algorithm will initiate a change of Energy Detect state regardless of threshold (error or data) and timer values. In managed applications, this bit can be set after clearing the Energy Detect interrupt to control the timing of changing the power state.
11	ED_BURST_DIS	0, RW	**Energy Detect Burst Disable:** Disable bursting of energy detect data pulses. By default, Energy Detect (ED) transmits a bursts of 4 ED data pulses. When bursting is disabled, only a single ED data pulse will be transmitted.
10	ED_PWR_STATE	0, RO	**Energy Detect Power State**: Indicates current Energy Detect Power state. When set, Energy Detect is in the powered up state. When cleared, Energy Detect is in the powered down state. This bit is invalid when Energy Detect is not enabled.
9	ED_ERR 0_MET	0, RO/COR	**Energy Detect Error Threshold Met:** No action is automatically taken upon receipt of error events. This bit is informational only and would be cleared on a read.
8	ED_DATA_MET	RO/COR	**Energy Detect Data Threshold Met**: The number of data events that occurred met or surpassed the Energy Detect Data Threshold. This bit is cleared on a read.
7:4	ED_ERR_COU0NT	001, RW	**Energy Detect Error Threshold:** Threshold to determine the number of energy detect error events that should cause the device to take action. Intended to allow averaging of noise that may be on the line. Counter will reset after approximately 2 seconds without any energy detect data events.
3:0	ED_DATA_COUNT	0001, RW	**Energy Detect Data Threshold**: Threshold to determine the number of energy detect events that should cause the device to take action. Intended to allow averaging of noise that may be on the line. Counter will reset after approximately 2 seconds without any energy detect data events.

4.3 Energy Detect Mode and Bursting

During Energy Detect mode, bursting should be disabled such that a single pulse will be transmitted instead of a burst of pulses. This setting will provide the most robust operation.

4.4 Energy Detect Mode and Auto MDIX

Energy Detect mode can operate with or without the Auto-MDIX (Automatic Medium Dependent Interface Crossover) mode of operation. In Auto-MDIX operation, the DP83848 will alternately swap transmit and receive pairs to determine the correct configuration for establishing link as part of Auto-Negotiation. In a low power state, Energy Detect uses the Auto-MDIX feature to alternate transmitting pulses on the transmit and receive cable pairs. Energy Detect will continue to monitor both transmit and receive cable pairs independent of which pair is used for transmission.

If Auto-MDIX is disabled, the transmit and received pairs are determined by the FORCE_MDIX control in the Phy Control Register (PHYCR, 0x19). While in a low power state, Energy Detect will monitor both transmit and receive cable pairs, but will only transmit on the pair selected.

4.0 Configuration of Energy Detect Mode (Continued)

In the DP83848, Auto-MDIX only operates if Auto-Negotiation is enabled. Therefore, Auto-MDIX should be disabled if Auto-Negotiation is disabled. See the DP83848 datasheet for additional details of Auto-MDIX operation.

4.5 Energy Detect Mode and Interrupts

Independent of the Energy Detect Control register settings, the DP83848 can be programmed to interrupt the system on an Energy Detect event. If the device is programmed to automatically power up or power down the device, the interrupt will indicate that the transition has occurred. If the device is not programmed to automatically power up or down, the interrupt will indicate that the energy detect event has occurred so that the device can be powered up or down manually via software control.

Note that an interrupt will also be signalled in the event of an energy detect error. In this case, the error status would be indicated in the Energy Detect Control register.

Energy Detect interrupts are enabled by setting the ED-_INT_EN bit in the MII Interrupt Status and Event Control Register (MISR, 0x12) as well as the general interrupt enable controls in the MII Interrupt Control Register (MICR, 0x11).

5.0 Summary

The Energy Detect feature provides an intelligent power saving operation mode for the DP83848. By providing a flexible and robust implementation, Energy Detect can deliver significant value in applications where power consumption is a consideration.

- Energy detect is a link managed power saving mode. The intent is to enter a dormant, very low power state when no activity is detected on the twisted pair.
- Energy detect functionality is controlled via register settings.
- When a transition occurs between power states, the power up/reset algorithm follows its normal procedure.
- Energy detect does not affect the previously configured mode of operation. The device will retain its mode (forced mode or Auto-Negotiation, MDI or MDIX) when transitions occur between power states.
- The energy detect algorithm can transition between power states automatically or manually.
- The energy detect logic can signal an interrupt when a change of power state is pending or when too many error events have occurred.
- Energy detect logic can accommodate some noise by requiring multiple data and/or error events before taking action. The counter depths are determined by register setting and default to one event for both data and error.

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