Introduction

The MAX5971B is a single-port power controller designed for use in IEEE® 802.3af/at-compliant power-sourcing equipment (PSE). This device provides powered device (PD) discovery, classification, current limit, and DC and AC load-disconnect detections. The MAX5971B supports both fully automatic operation and software programmability, and features an integrated power MOSFET and sense resistor. The device supports detection and classification operation from a single 54V supply. In addition, it supports 2-event classification and new Class 5 classification of high-power PDs. The MAX5971B provides up to 40W to a single port (Class 5 enabled) and still provides high-capacitance detection for legacy PDs.

Key features include the following:

- IEEE 802.3af/at Compliant
- Up to 40W for Single-Port PSE Applications
- Integrated Power MOSFET and Sense Resistor
- Supports 54V Single-Supply Operation
- PD Detection and Classification
- Supports Both AC Load and DC Load Detections
- LED Indicator for Port Status

Hardware Specification

This is a minimum component design of a PSE controller board using the MAX5971B for the detection and classification of PD, especially for DC disconnect detection. Table 1 shows an overview of the design specification.

Hardware Needed for Quick Setup

- DC power supply capable of delivering -32V to -60V and 1A
- MAXREFDES1015# board
- Power device controller (MAX5969B)
- CAT5 cable

Designed–Built–Tested

This document describes the hardware shown in Figure 1. It provides a detailed systematic technical guide to designing the MAX5971B PSE controller for DC-disconnect. Refer to the MAX5971B IC data sheet and MAX5971B EV kit data sheet for device operation details. The controller design been built and tested, details of which follow later in this document.

Table 1. Design Specification

PARAMETER	SYMBOL	MIN	MAX
Input Voltage	V_{IN}	-32V	-60V
Output Voltage	V_{OUT}	-32V	-60V

Figure 1. MAXREFDES1015 hardware.

IEEE is a registered service mark of the Institute of Electrical and Electronics Engineers, Inc.

PSE Controller Operation and 802.3 at/af Standard

The 802.3 at/af is an IEEE standard for powering up devices over the ethernet. The basic idea is to transfer power and data simultaneously. This architecture specifically involves two devices: power-sourcing equipment (PSE) and a powered device (PD). A PSE is a network switch that provides power on the ethernet cable. The PD is a device that consumes the power. The MAX5971B is the PSE controller used in this design to power up a PD. The operation involves the following steps:
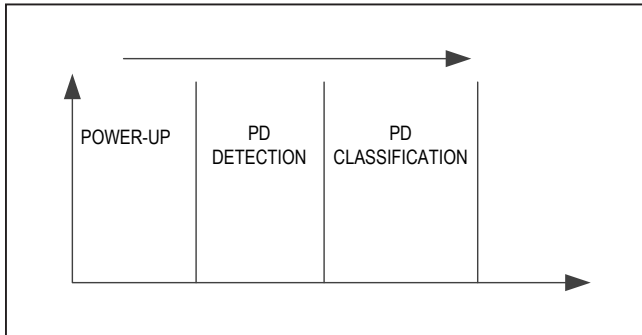
In this application, the MAX5971B by default enters to the automatic mode, and powers up the port automatically if a valid PD is connected to the port. If a valid PD is not connected at the port, the MAX5971B repeats the detection routine continuously until a valid PD is connected.

Power-Up

Initially, the board is powered with -56V input voltage, however, any voltage between -32V and -60V can be used. Next, connect the load at the J2 jumper using a Cat 5 cable.

PD Detection

During normal operation, the MAX5971B probes the output for a valid PD. A valid PD has a 25kΩ discovery signature characteristic as specified in the IEEE 802.3af/802.3at standard. For a valid PD detection in case of DC disconnect the load should be a able to pull a current greater than or equal to 17mA. The MAX5971B needs a valid PD controller as the load. The MAX5969AEVKIT

board is considered in this design. The MAX5969A board has MAX59869A IC followed by a DC-DC power converter capable of delivering 12V and 1.9A of output current. This board provides a signature resistance of 24.9kΩ for the MAX5971B. An LED indication is used in this design, which monitors the PD detection with the following LED indications:

1) The LED is turned on when the port is connected to a valid PD and powered. If the port is not powered or is disconnected, the LED is off.

2) For two other conditions, the MAX5971B blinks a code to communicate the port status. A series of two flashes indicates an overcurrent fault occurred during port power-on.

3) A series of five flashes indicates that during detection an invalid low or high discovery signature resistance was detected.

4) The output of the MAX5969A board is connected to different loads as shown in Table 2 that shows a valid PD detection.

PD Classification

During PD classification, the MAX5971B forces a probe voltage (-18V, typ) at DET and measures the current into DET. The measured current determines the class of the PD. Since the output of MAX5971B is connected to the MAX5969A (PD controller), now the PD classification is done using the MAX5969A as explained below.

Table 2. Output Load Conditions for Valid PD Detection

LOAD RESISTOR (Ω)	CURRENT = (12V/LOAD RESISTOR) (mA)
300	40
560	21
680	17
750	16
820	14.6
1000	12

PD Classification Using MAX5969A

In the classification mode, the PSE classifies the PD based on the power consumption required by the PD. This allows the PSE to efficiently manage power distribution. Class 0 to 5 is defined as shown in Table 3. (The IEEE 802.3af/at standard defines only Class 0 to 4 and Class 5 for any special requirement.) An external resistor (R_{CLS}) connected from CLS to V_{SS} sets the classification current. The PSE determines the class of a PD by applying a voltage at the PD input and measuring the current sourced out of the PSE. When the PSE applies a voltage between 12.6V and 20V, the MAX5969A/MAX5969B exhibit a current characteristic with a value shown in Table 1. The PSE uses the classification current information to classify the power requirement of the PD. The classification current includes the current drawn by R_{CLS} and the supply current of the MAX5969A/MAX5969B so the total current drawn by the PD is within the IEEE 802.3af/at standard figures. The classification current is turned off whenever the device is in power mode.

Table 3. Setting Classification Based on CLS Resistor

CLASS	MAXIMUM POWER USED BY PD	R_{CLS} (Ω)
0	0.44 to 12.95	619
1	0.44 to 3.94	117
2	3.84 to 6.49	66.5
3	6.49 to 12.95	43.7
4	12.95 to 25.5	30.9
5 (not used in the design)	> 25.5	21.3

Note: V_{IN} is measured across the MAX5969A/MAX5969B input V_{DD} to V_{SS}.

Design Procedure for DC-Disconnect Detection Using MAX5971B

This reference design is to develop an application circuit using the MAX5971B for DC-disconnect detection using minimal components. The pin configuration is explained as follows:

1) The power supply (-56V) is given to V_{EE} (any range between -32V and -60V can be used) and the ground is connected to the positive terminal.

2) Since this is a minimal component design, the MAX5971B is operated in automatic mode since no external control is used. The SCL, SDA, AD0, and $\overline{INT}$ pins are connected to V_{EE}.

3) This application is designed in such a way that there is no internal oscillator, pulse-width modulation, legacy detection, and midspan detection, hence, the OSC, PWMEN, MIDSPAN, and LEGACY are connected up to V_{EE}.

4) The enable pin EN is left unconnected, which enables the device.

5) Since this is a DC-disconnect design, the OUTP, OUT pins are connected together to the anode of D3 and the cathode of the diode is connected to DET (detection/classification of voltage).

6) The output is taken across the OUTP (RTN) and the GND. These two pins are connected to J2.

7) An LED indication is used to analyze and understand the operation of MAX5971B, and the LED pins of the MAX5971B are connected to RJ45.

8) This design is only compatible up to Class4 classification. Since there is no Class 5, the pins ILIM1, ILIM2 are left unconnected.

9) Transient voltage suppression diode D2 is used to protect the IC.

10) Different test points are installed to monitor the status of different pins.

Design Resources

Download the complete set of **Design Resources** including the schematics, bill of materials, PCB layout, and test files.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/17	Initial release	—