PD70100A & PD70200

IEEE 802.3af/at PD Front End IC

PRODUCT DATA SHEET

DESCRIPTION

The PD70100AA and PD70200 devices are part of Microsemi's™ series of Power over Ethernet (PoE) Powered Devices chips (PD). The PD70100AA and PD70200 devices transmit integrated power and analog data in a single 12-pin package. They are used in Powered Devices (PD), thus enabling next generation network devices to share power and data over the same cable.

Microsemi's new PD family offers a solution to any PD application compliant with IEEE802.3af and IEEE802.3at standards and 4-pairs extra power applications. The IC family's components can be used in both indoor and outdoor applications.

The device family meets all PD-side-standards such as:

- Detection
- Classification
- Integrated isolation switch with inrush current limiter, and over-current protection.
- Two-events classification recognition and AT flag generation (PD70200 only).

In addition, the devices have a discharge mechanism for a DC/DC input capacitor, ensuring quick redetection capability in case the RJ-45 plug is disconnected and reconnected within a short time span.

PD70200 IC design specifically supports IEEE802.3at standard, including two-events classification detection that enables the PD to distinguish whether the connected power source equipment (PSE) is IEEE802.3at or IEEE802.3af based.

The PD70100AA/PD70200 ICs are designed to support 4-pair applications for PDs that require higher power.

IMPORTANT: For the most current data, consult *MICROSEMI*'s website: http://www.microsemi.com

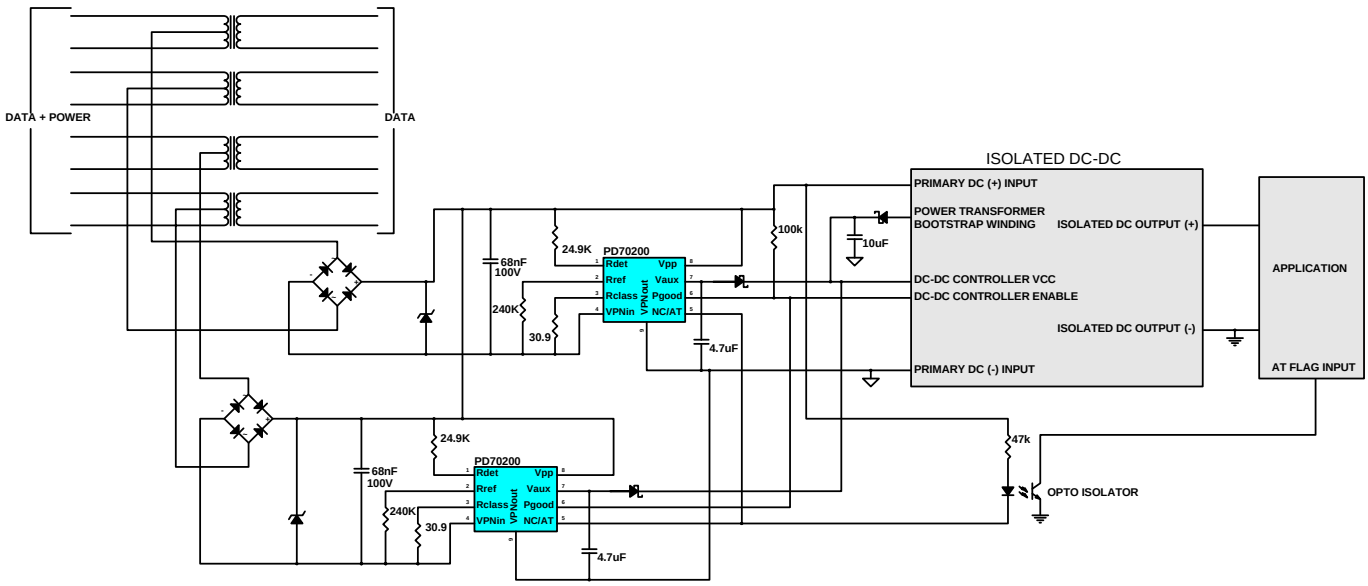
KEY FEATURES

- Designed to Support IEEE802.3af and IEEE802.3at standards
- PD Detection & Programmable Classification Signature
- Two-events Classification Flag
- Signature Resistor Disconnection after Detection
- Integrated 0.6Ω Isolating Switch and Inrush Current Limiter.
- 4-pairs support with a single IC for up to 48W
- 4-pairs support with two ICs for up to 96W
- Less than 10µA Offset Current during Detection
- Single DC Voltage Input (37V-57V)
- Wide Operating Temperature Range: -40° to +85°C
- On-chip Thermal Protection
- 12-pin 3x4mm Package
- RoHS Compliant

APPLICATIONS

- Power over Ethernet Powered Devices
- IEEE802.3af & at 10/100/1000 BASE-T
- 4-pair Extra Power Applications
- Indoor as Well as Outdoor Applications

TYPICAL APPLICATION



PD70100A & PD70200

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1 Enterprise, Aliso Viejo, CA 92656, USA; Within the USA: (800) 713-4113, Outside the USA: (949) 221-7100 Fax: (949) 756-0308

ABSOLUTE MAXIMUM RATINGS

Supply Input Voltage(V_{PP}) ..... -0.3V to 74 V_{DC}
Port Negative Out Voltage (VPN_{OUT}) ..... -0.3V to 74 V_{DC}
R_{DET} ..... -0.3V to 74 V_{DC}
R_{CLASS}, R_{REF} ..... -0.3V to 5 V_{DC}
VAUX ..... -0.3V to 30 V_{DC}
PGOOD, AT_FLAG (with respect to VPN_{OUT}) ..... -0.3V to 74 V_{DC}
ESD Protection* ..... ±1.5kV HBM
Maximum Operating Junction Temperature ..... 150°C
Operating Ambient Temperature ..... -40°C to 85°C
Storage Temperature Range ..... -65°C to 150°C
Peak Package Solder Reflow Temp (40 seconds max exposure) ..... 260°C

*All pins except pin 11 (VAUX). Pin 11 ESD Protection ±150V HBM.

Notes: Exceeding these ratings could cause damage to the device. All voltages are with respect to VPN_{IN}. Currents are positive into, negative out of specified terminal. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" are not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

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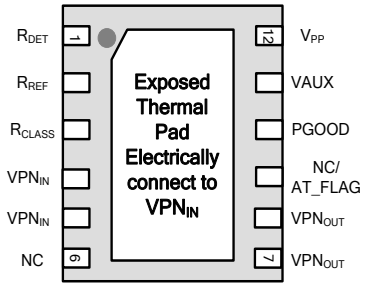
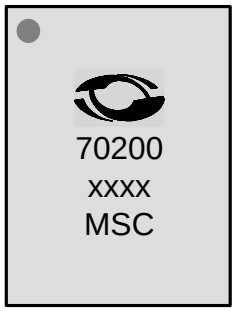
PACKAGE PIN OUT



DFN PACKAGE
(Top View)



DFN PACKAGE MARKINGS
"xxxx" Denote Date Code and Lot Identification

RoHS / Pb-free 100% matte Tin Pin Finish

PACKAGE ORDER INFO		THERMAL DATA
T_A (°C)	*12 Pins DFN 4x3*	40 ° C/W THERMAL RESISTANCE-JUNCTION TO AMBIENT
	RoHS Compliant / Pb-free	4 ° C/W THERMAL RESISTANCE-JUNCTION TO CASE
-40 to 85	**PD70100AAILD (IEEE802.3af)** **PD70200ILD (IEEE802.3at)**	Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$. The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.
Note: Available in Tape & Reel. Append the letters "TR" to the part number. (i.e. PD70200ILD-TR)		

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ELECTRICAL CHARACTERISTICS

Unless otherwise specified, the following specifications apply over the operating ambient temperature -40°C ≤ T_{AMB} ≤ 85°C. Production tests are done at 25°C T_A.

Parameter	Symbol	Test Conditions / Comment	PD70100A/PD70200			Units
			Min	Typ	Max	
Power Supply						
Input Voltage	V_{PP}	Supports Full IEEE802.3 af/at functionality	0	55	57	V
Power Supply Current at Operating Mode		V_{PP} = 55V		1	3	mA
DETECTION MODE						
Detection is connected. At this voltage range R_{DET} must be on.	DET_{RANGE}	Measured between V_{PP} and VPN_{IN}	1.3		10.1	V
Detection Switch ON Resistance PD-detection	R_{DET}-on	2.5V ≤ (ΔV_{PP} to VPN_{IN}) ≤ 10.1V Measured between R_{DET} and VPN_{IN}			50	Ω
Detection is Disconnected	R_{DET}-off	Measured between V_{PP} and VPN_{IN}	10.1		12.8	V
Detection Switch OFF Resistance	R_{DET}-off	12.8V ≤ (ΔV_{PP} to VPN_{IN}) ≤ 57.0V Measured between R_{DET} and VPN_{IN}	2.0			MΩ
Input Offset Current	I_{OFFSET}	1.1V to 10.1V -40°C ≤ T_J ≤ 85°C			16	µA
	I_{OFFSET}	1.1V to 10.1V -40°C ≤ T_J ≤ 55°C			10	µA
R_{DET} Reconnection Level, V_{PP} Falling	V_{RDET}-on	Measured between V_{PP} and VPN_{IN}	1.95	3.0	4.85	V
CLASSIFICATION MODE						
Classification Current Source, Turn ON Threshold Range Measured at V_{PP}	V_{TH}-low-on	Turn on for any I_{CLASS} while V_{PP} increases	11.4		13.7	V
Classification Disconnection Minimum Hysteresis Voltage.	V_{HST}	Hysteresis between V_{TH}-low-on and V_{TH}-low-off		1		V
Classification Current Source, Turn OFF Threshold Range Measured at V_{PP}	V_{TH}-high-off	Turn off while V_{PP} increases	20.9		23.9	V
Current Limit Threshold	I_{CLASS}-LIM		50.0	68	80.0	mA
Input Current I_{PP} When Classification Function is Disabled	I_{CLASS}-DIS	Class 0 R_{CLASS}=Disconnect			3.0	mA
Input Current I_{PP} When Classification Function is Enabled	I_{CLASS}-EN	Class 1 R_{CLASS}= 133Ω±1%	9.50	10.5	11.5	mA
		Class 2 R_{CLASS}= 69.8 Ω±1%	17.5	18.5	19.5	mA
		Class 3 R_{CLASS}= 45.3 Ω±1%	26.5	28.0	29.5	mA
		Class 4 R_{CLASS}= 30.9 Ω±1%	38.0	40.0	42.0	mA

MARK						
Mark, Working Voltage Range	V_{MARK}	When voltage decreases Measured between V_{PP} to VPN_{IN}	4.9		10.1	V
Mark Current	I_{MARK}	Chip current	0.25		4	mA
ISOLATION SWITCH						
Isolation Switch MOSFET Switches from Off to $I_{LIM-LOW}$	$V_{SW-START}$		36			V
Isolation Switch MOSFET Switched Off	V_{SW-OFF}		30.5		34.5	V
Startup Current Limit, I_{LIM}	$I_{LIM-LOW}$		105	240	325	mA
VPN_{IN} to VPN_{OUT} Threshold Voltage for $I_{LIM-LOW}$ to $I_{LIM-HIGH}$ Switchover	V_{DIFF}	When VPN_{IN} to VPN_{OUT} ≤ V_{DIFF}, Isolating switch switches over from $I_{LIM-LOW}$ to $I_{LIM-HIGH}$.			0.7	V
Over Current Protection Current Limit	OCP		1500	1800	2000	mA
Continuous Operation Load Current	I_{LOAD}	Isolating switch at $I_{LIM-HIGH}$ PD70100A PD70200		 350 600	 450 1123	 mA mA
Continuous Operation Total RDS_{ON}	SW-RDS_{ON}	Total resistance between VPN_{IN} and VPN_{OUT} Isolating switch at $I_{LIM-HIGH}$			0.6	Ω
DC/DC CAPACITOR DISCHARGER						
DC/DC Input Capacitance		For reference only Guaranteed by design (not tested on production)		220		µF
Discharge Current.		7.0V ≤ VPP to VPN_{OUT} ≤ 30V	22.8	32	50	mA
Full Discharge Time for Full Discharge of Input Capacitance	T_{DSC}	V_{PP} < UVLO threshold Guaranteed by design (not tested in production)			500	ms
AT_FLAG						
Output Low Voltage		I_{OL} = 0.75mA			0.4	V
		I_{OL} MAX = 5mA			2.5	V
Leakage Current		V_{ATFLAG} = 57V			1	µA
PGOOD						
Output Low Voltage		I_{OL} = 0.75mA			0.4	V
		I_{OL} MAX = 5mA			2.5	V
Leakage Current		V_{PGOOD} = 57V			1	µA

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THERMAL SHUTDOWN						
Thermal Shutdown Temperature			180	200	220	°C
VAUX		Reference to VPN_{OUT}				
VAUX Output Voltage Off (leakage current)	VAUX-off	PGOOD = High impedance Load = 1MΩ			1	V
VAUX Output Voltage On	VAUX-on	Isolating switch at $I_{LIM-HIGH}$ and PGOOD = Low	9.5	10.5	11.8	V
Output Current Peak	I_{VAUXP}	Capacitor = 30uF When $T_{LOAD} \leq$ 5mS Isolating switch at $I_{LIM-HIGH}$ and PGOOD = Low	0		10	mA
Output Continuous Current	I_{VAUXC}	When $T_{LOAD} \leq$10mS Isolating switch at $I_{LIM-HIGH}$ and PGOOD = Low	0		2	mA
VAUX Output Current Limit	I_{VAUX}	Isolating switch at $I_{LIM-HIGH}$ and PGOOD = Low	10		32	mA

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PD70100A Functional Block Diagram

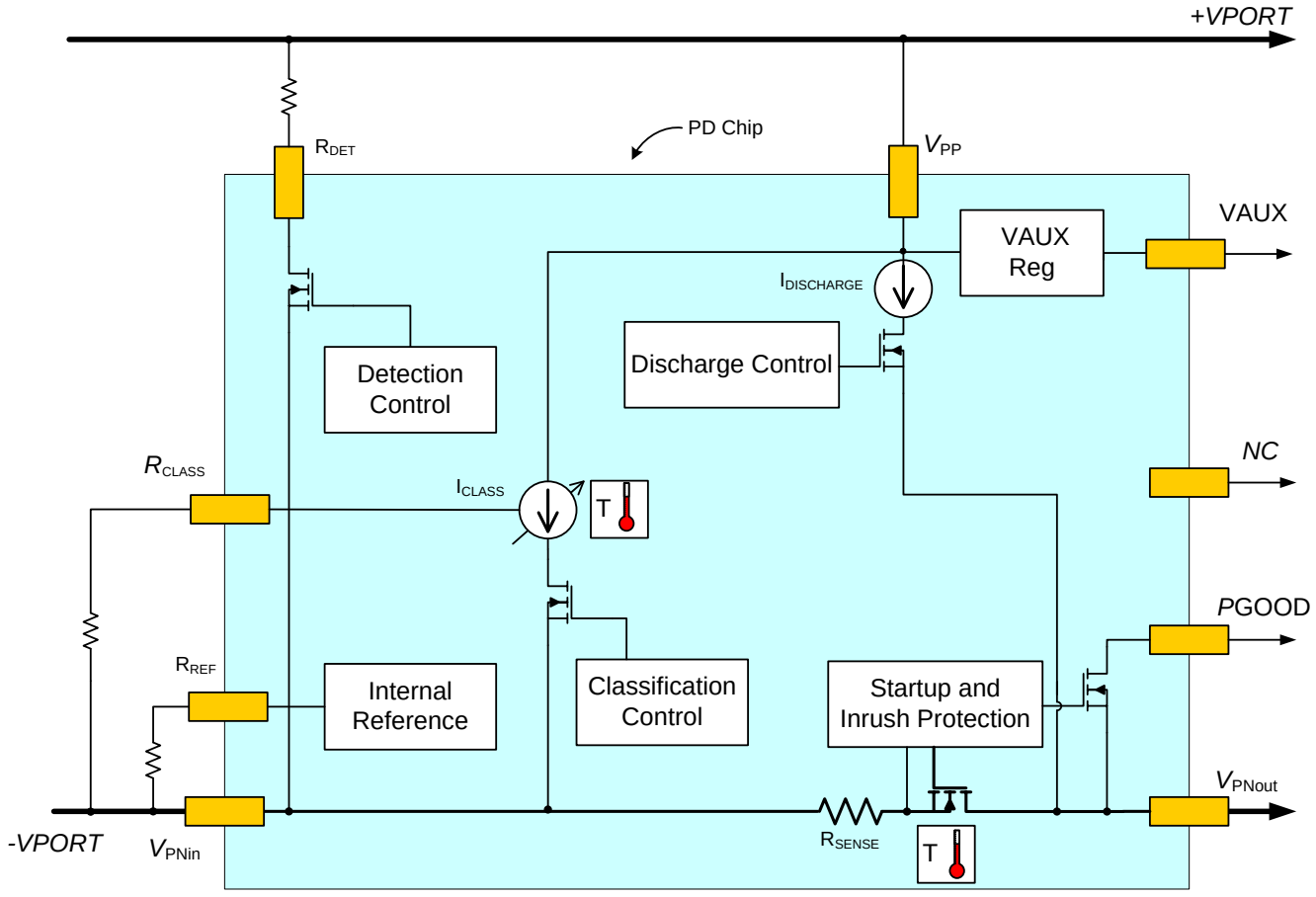

Figure 1: PD70100A Functional Block Diagram

PD70200 Functional Block Diagram

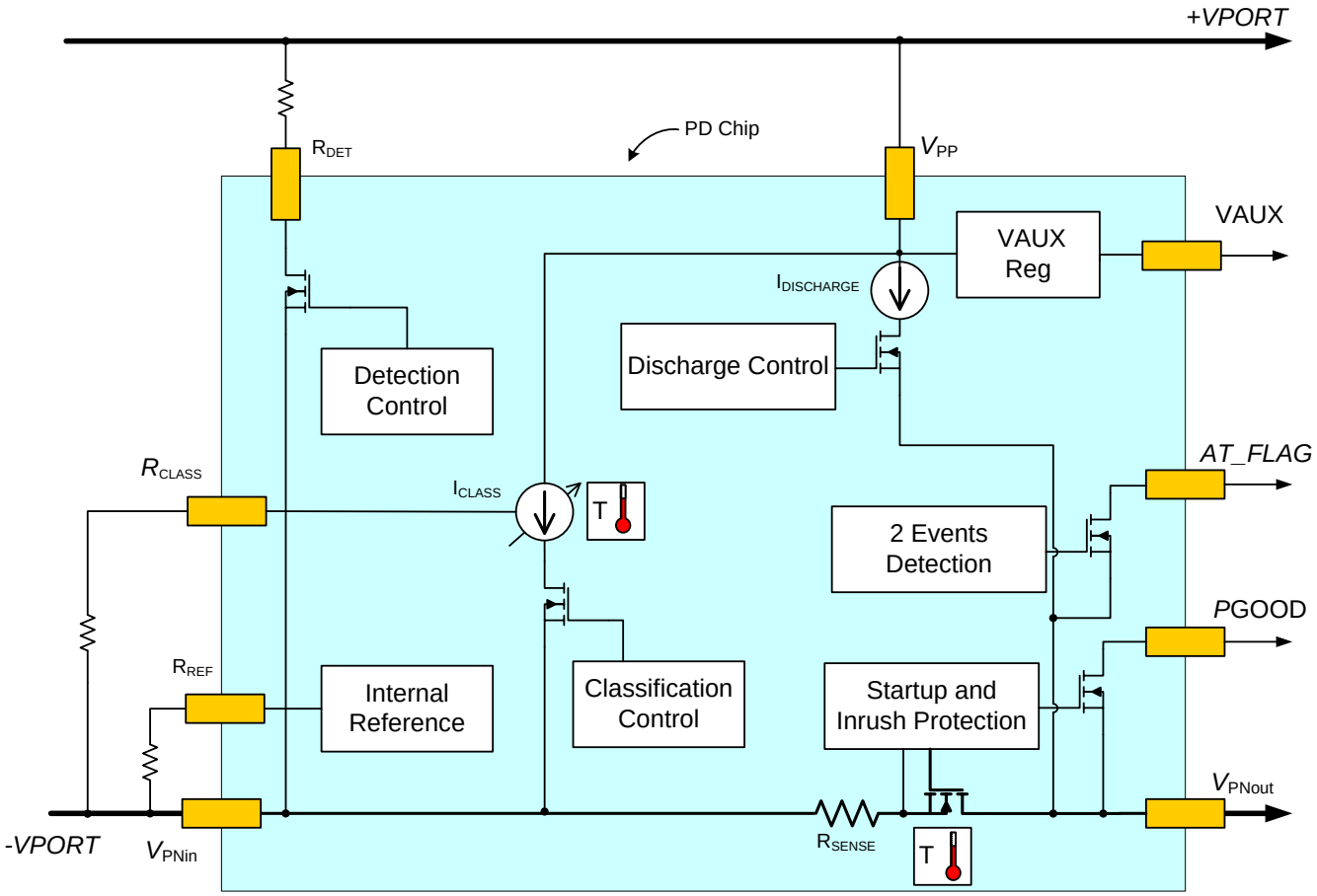

Figure 2: PD70200 Functional Block Diagram

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FUNCTIONAL PIN DESCRIPTION				
Pin	**PD70100A Pin Name**	**PD70200 Pin Name**	**Type**	**Description**
1	R_{DET}	R_{DET}		Valid Detection resistor. Connect external 24.9KΩ detection resistor between RDET and VPP
2	R_{REF}	R_{REF}		Bias current resistor
3	R_{CLASS}	R_{CLASS}		Power classification setting. Connect external class resistor between RCLASS and VPN_{IN}
4	VPN_{IN}	VPN_{IN}	Power	VPort Negative input. Connected to the isolating SW input. N-channel MOSFET source. The exposed thermal PAD should be connect to these pins.
5				
6	N.C	N.C		
7	VPN_{OUT}	VPN_{OUT}	Power/Gnd	Vport Negative output. Connected to the isolating SW output. N-channel MOSFET Drain. Primary side Ground. A decent ground plane should be deployed around this pin whenever is possible
8				
9	N.C	AT_FLAG	Open drain	The two-event detector should discern between AF and AT classification waveforms and outputs the AT_FLAG
10	PGOOD	PGOOD	Open drain	After startup a PGOOD flag is generated in order to optionally inform the application DC/DC converter that the power rails are ready.
11	VAUX	VAUX	Power	Auxiliary output voltage to VPN_{OUT}. Can be used for DC-DC startup for bootstrap initiation.
12	VPP	VPP	Power	High voltage positive input, Reference to VPN_{IN} And High voltage positive out, Reference to VPN_{OUT} (used for discharge as well)
EP	EPAD	EPAD		Connect to VPN_{IN}. EPAD should be connected to a large copper area for improved thermal management.

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THEORY OF OPERATION

DETAIL DESCRIPTION

PD70100A/PD70200 IC provides IEEE 802.3af/at compliant PD Front-End functions including Detection, Physical Layer Classification, Two-Events Classification (PD70200 only), Auxiliary Voltage Output, Power Good, Soft-Start Current Limiting, Over-Current Protection, and Bulk Capacitor Discharge.

DETECTION

IEEE 802.3af/at compliant detection is provided by means of a 24.9KΩ resistor connected between V_{PP} and R_{DET} pin. R_{DET} pin is connected to VPN_{IN} via an open drain MOSFET with a maximum specified RDS_{ON} of 50Ω. Internal logic monitors V_{PP} to VPN_{IN} and connects the R_{DET} pin to VPN_{IN} when the rising V_{PP} to VPN_{IN} voltage is between 2.5V and 10.1V. When rising V_{PP} to VPN_{IN} voltage exceeds 10.1V, the MOSFET is switched off. Once above 10.1V, falling V_{PP} to VPN_{IN} voltage between 2.45V and 4.85V will reconnect R_{DET} pin to VPN_{IN}.

PHYSICAL LAYER CLASSIFICATION

Physical Layer (hardware) Classification per IEEE 802.3af/at is generated via a regulated reference voltage of 1.2V, switched onto the R_{CLASS} pin. Internal logic monitors the V_{PP} to VPN_{IN} voltage and connects the 1.2V reference to R_{CLASS} pin at a rising V_{PP} to VPN_{IN} voltage threshold between 11.1V and 13.5V. Once V_{PP} to VPN_{IN} has exceeded the rising threshold, there is a 1V minimum hysteresis between the V_{PP} rising (turn-on) threshold and the V_{PP} falling (turn-off) threshold.

The 1.2V reference stays connected to the R_{CLASS} pin until the V_{PP} to VPN_{IN} rising voltage exceeds the upper turn-off threshold of 20.9V to 23.9V. The 1.2V reference voltage is disconnected from the R_{CLASS} pin at V_{PP} to VPN_{IN} voltages above the upper threshold.

Classification current signature is provided via a resistor connected between R_{CLASS} pin and VPN_{IN}. The classification current is therefore the current drawn by the PD70100A/PD70200 IC during the classification phase, and is simply the 1.2V reference voltage divided by the R_{CLASS} resistor value. The maximum current available at the R_{CLASS} pin is current limited to 55mA (typical).

TWO-EVENTS DETECTION AND AT FLAG

The PD70200 IC provides IEEE 802.3at Type 2 compliant detection of the "Two Events Classification Signature", and generation of the AT flag. This feature is available on the PD70200 IC only.

Simply put, the "Two Events Classification Signature" is a means by which an IEEE 802.3at Type 2 Power Source can inform a compliant Power Device (PD) that it is AT Type 2 compliant, and as such is capable of providing AT Type 2 power levels.

The Power Source communicates with a Type 2 compliant signature by toggling the V_{PP} to VPN_{IN} voltage twice (2 "events") during the Physical Layer Classification phase. The V_{PP} to VPN_{IN} voltage is toggled from the Physical Layer Classification's voltage level (13.5V to 20.9V) down to a voltage "Mark" level. Voltage "Mark" level is specified as a V_{PP} to VPN_{IN} voltage of 4.9V to 10.1V.

PD70200 IC recognizes a V_{PP} to VPN_{IN} falling edge from Classification level to Mark level as being one event of the Two-Events Signature. If two such falling edges are detected, PD70200 will assert AT flag by means of an open drain MOSFET connected between AT_FLAG pin and VPN_{OUT}.

AT_FLAG pin is active low; a low impedance state between AT_FLAG and VPN_{OUT} indicates a valid Two-Events Classification Signature was received, and the Power Source is AT Type 2 compliant.

AT_FLAG MOSFET is capable of 5mA of current and can be pulled up to V_{PP}.

SOFT START AND INRUSH CURRENT PROTECTION

PD70100A/PD70200 IC contains an internal isolation switch, that provides ground isolation between Power Source and PD application during Detection and Classification phases. The isolation switch is a N-channel MOSFET, wired in a common source configuration where the MOSFET's Source is connected to Power Source ground at VPN_{IN}, and the MOSFET's Drain is connected to application's primary ground at VPN_{OUT}.

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THEORY OF OPERATION

Internal logic monitors V_{PP} to VPN_{IN} voltage and keeps the MOSFET in a high impedance state until V_{PP} to VPN_{IN} voltage reaches turn-on threshold of 36V to 42V. Once V_{PP} to VPN_{IN} voltage exceeds this threshold, the MOSFET is switched into one of two modes.

The mode into which the MOSFET is switched is determined by the voltage developed across the MOSFET, or put another way, the VPN_{OUT} to VPN_{IN} differential voltage. Two modes are defined below:

Isolation Switch Modes

VPN_{OUT} to VPN_{IN}	Mode	Description
> 0.7V	Soft Start Mode	Limits VPN_{OUT} current to 240mA (typical)
≤ 0.7V	Normal Operating Mode	Limits VPN_{OUT} current to 1.8A (typical)

By controlling the MOSFET current based on VPN_{OUT} to VPN_{IN} voltage, inrush currents generated by fully discharged bulk capacitors can be limited. This method limits current to a maximum of 350mA, compliant with IEEE 802.3af/at specification.

Soft Start current limiting is required to reduce occurrences of voltage sag at the PD input during device power-up. A comparison is shown in Figure 3.

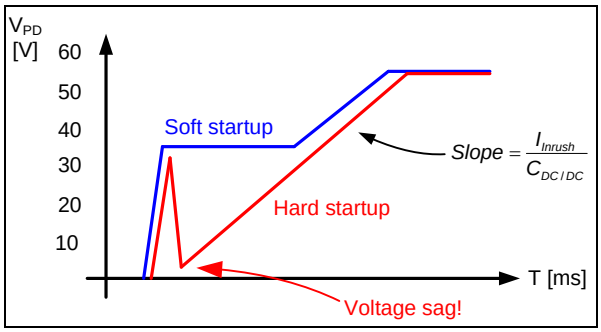

Figure 3. Comparison of input voltages without Soft Start (Hard startup), and with Soft Start (Soft startup).

Once bulk capacitance has charged up to a point where VPN_{OUT} to VPN_{IN} differential voltage is less than 0.7V, the isolation MOSFET is switched into normal operating mode with MOSFET current limit set at 1.8A (typical), to provide over-current protection.

PD70100A and PD70200 ICs are different in their respective isolation MOSFET's continuous current handling capability:

PD70100A: 450mA (max.)

PD70200: 1123mA (max.)

An adequate heat sink for the PD70100A/PD70200 IC's exposed pad must be provided to achieve these current levels without damaging the IC. A large, heavy copper fill area and/or a heavy ground plane with Thermal Vias is recommended. Electrically the exposed pad ground plane should be connected to VPN_{IN}.

Internal logic monitoring V_{PP} to VPN_{IN} will place the isolation switch MOSFET in a high impedance state if voltage between V_{PP} and VPN_{IN} drops below 31V to 34V.

OVER-CURRENT PROTECTION

Over-current protection is provided on the PD70100A/PD70200 IC using the Isolation MOSFET Switch, which limits the VPN_{OUT} current to 1.8A during normal operation. See previous description of Soft Start.

POWER GOOD

During Soft-Start mode, the PD70100A/PD70200 IC monitors VPN_{OUT} to VPN_{IN} differential voltage. When this voltage is less than 0.7V (max.), the IC enters normal operation mode and the isolation switch current limit is increased to 1.8A (typical). At this same 0.7V (max.) threshold the Power Good signal is asserted by means of an open drain MOSFET between PGOOD and VPN_{OUT}.

PGOOD pin is active low; a low impedance state between PGOOD and VPN_{OUT} indicates the Soft-start mode has finished and the isolation switch has transitioned into normal operating mode.

PGOOD MOSFET can handle current of 5mA and can be pulled up to V_{PP}.

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THEORY OF OPERATION

AUXILIARY VOLTAGE OUTPUT

PD70100A/PD70200 IC provides a 10.5V (typical) regulated output to be used as a start-up supply for DC/DC controllers whose V_{CC} is provided via a bootstrap winding. This regulated supply is available at VAUX pin, and is referenced to VPN_{OUT} pin. VAUX supply is designed for low-duty operation, and should not be designed as a primary housekeeping supply. The current capability is continuous 2mA, with 10mA peak (≤10ms). VAUX output is current-limited at 10mA (min.).

For stability, the VAUX regulator requires a minimum of 4.7µF ceramic capacitor connected directly between VAUX and VPN_{OUT} pins.

THERMAL PROTECTION

Both PD70100A and PD70200 IC include temperature sensors which individually monitor both the isolation MOSFET and the Classification Current Source for over temperature conditions. In case of an over temperature condition, the sensor will activate protection circuitry which will disconnect its respective monitored function.

BULK CAPACITOR DISCHARGE

The bulk capacitor discharge circuitry eliminates the need to place a diode in series with the V_{PP} line to prevent an application's bulk capacitance from discharging through the detection resistor and the isolation switch MOSFET's body diode. Discharge current through the detection resistor can cause failure of the detection signature in cases where a PD is connected and the bulk capacitance is not fully discharged.

During normal operation, PD70100A/PD70200 IC continuously monitors voltage at V_{PP} to VPN_{IN}. Should V_{PP} to VPN_{IN} voltage fall below isolation switch turn-off threshold (31V to 34V), isolation switch MOSFET is immediately placed in a high-impedance state. At this point the internal logic monitors the voltage at V_{PP} to VPN_{OUT}. If V_{PP} to VPN_{OUT} voltage is between 1.5V to 32V, a 23mA (min.) constant current source is connected across the V_{PP} and VPN_{OUT} pins. This constant current source provides bulk capacitor discharge.

A 220µF bulk capacitance can be discharged from 32V to 1.5V in a maximal period of 292ms.

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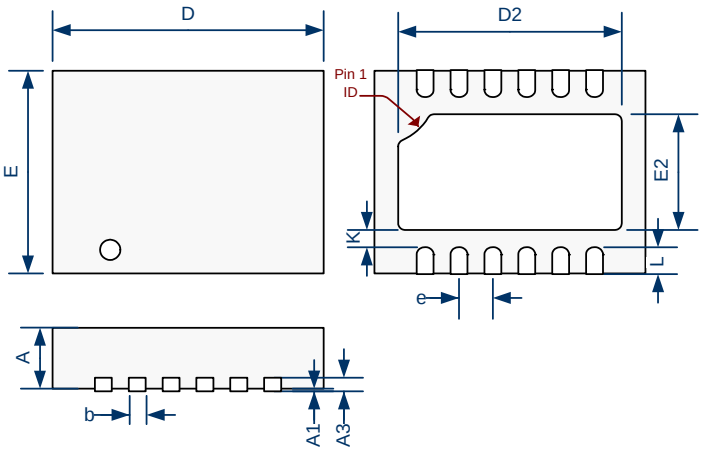
LD

12 Pin Plastic DFN 4x3 mm



Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.80	1.00	0.031	0.039
A1	0.00	0.05	0.000	0.002
A3	0.20 REF		0.008 REF	
D	4.00 BSC		0.157 BSC	
E	3.00 BSC		0.118 BSC	
D2	3.00	3.70	0.118	0.146
E2	1.40	1.80	0.055	0.071
e	0.50 BSC		0.0197 BSC	
K	0.20 MIN		0.008 MIN	
L	0.30	0.50	0.012	0.020
b	0.18	0.30	0.007	0.012

Note:

1. Dimensions do not include mold flash or protrusions; these shall not exceed 0.155mm(.006") on any side. Lead dimension shall not include solder coverage.

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Revision History

Revision Level / Date	Para. Affected	Description
0.1 / April 2010		Preliminary Release
0.3 / June 2010		Add Classification Pulse Diagrams
0.3 27 Jul 10		Changing catalog numbers metrology
0.3 12 Nov 10		Extensive changes to document format and Theory of Operation; corrected package drawing; added Product Highlight and Typical Characteristics
0.4 Dec 23 2010		Package update
0.5 Jan 05 2011		Package update
0.6 Jul 13 2011		Specification Update
1.1 Feb 2012		Updated Document Address Footer

For support contact: sales_AMSG@microsemi.com

Visit our web site at: www.microsemi.com **Cat. Num: DS_PD70100A_PD70200**