AS23xx

Secondary Side Housekeeping Circuit

Features

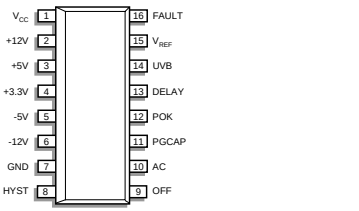
- Standard PC Power Good:
  - UV Detection on 4 rails
  - UV Detection of AC/Bulk supply
  - OV Detection on 4 rails
  - Open collector PG out
- Pogrammable Fault output:
  - OV
  - OV plus UV
  - OV plus UV after startup delay
- OV Crow Bar Driver
- Digital ON/OFF input
- 2.5V Voltage Reference
- Operates from 5V or 12V rail

Description

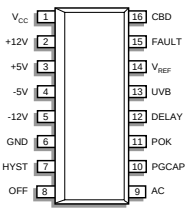
The AS23xx is a housekeeping circuit for monitoring the outputs of power supplies. It directly senses all the output rails without the need for external dividers and detects undervoltage and overvoltage. It also provides an additional undervoltage comparator which may be configured with any arbitrary hysteresis to sense a divided down representation of the AC bulk voltage. The housekeeping section provides all the features necessary to allow external caps to set the common timing features of PC type power supplies. In addition, negative rails may be sensed without the necessity of a V_{EE} connection, and negative sensing may be disabled without affecting operation of the positive sense section. The 2.5 V series reference is available and can source up to 5 mA. This IC is available in 16 lead packages. Outputs include a POK (Power OK) and a fault signal.

The AS2333 includes sensing for ±12 V, 5 V, and 3.3V. The AS2350 exchanges a -5 V sense capability for the 3.3 V input. The AS2316 monitors all supply voltages, but lacks CBD (Crow-Bar Driver).

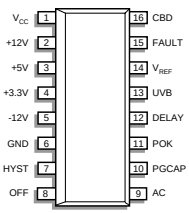
Pin Configuration — Top view



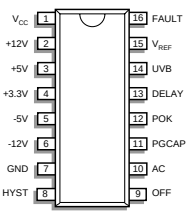
AS2316 SOIC



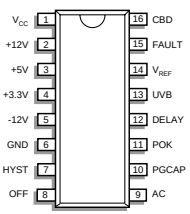
AS2333 SOIC



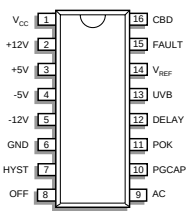
AS2350 SOIC



AS2316 PDIP



AS2333 PDIP



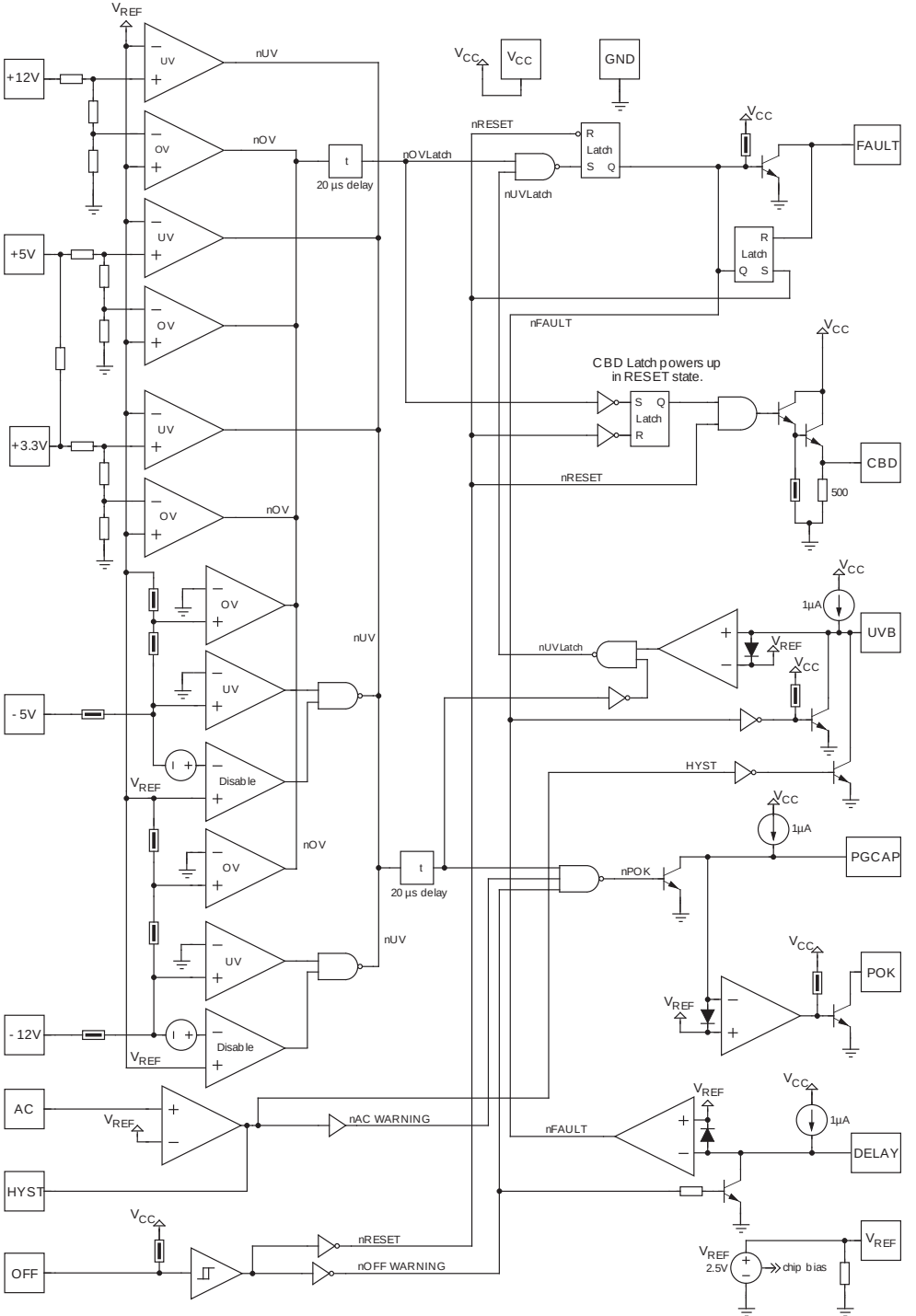
AS2350 PDIP

Ordering Information

Package	Temperature Range	Order Code
16-Pin Plastic SOIC	0 to 105° C	AS2316D
16-Pin Plastic SOIC	0 to 105° C	AS2333D
16-Pin Plastic SOIC	0 to 105° C	AS2350D
16-Pin Plastic DIP	0 to 105° C	AS2316N
16-Pin Plastic DIP	0 to 105° C	AS2333N
16-Pin Plastic DIP	0 to 105° C	AS2350N

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Functional Block Diagram



Pin Function Description (For AS2333 / AS2350)

Pin Number	Function	Description
1	V_{CC}	Power input to the chip.
2	+12 V	Input for overvoltage and undervoltage for the +12 V rail.
3	+5 V	Input for overvoltage and undervoltage for the +5 V rail.
4	+3.3/–5 V	Input for overvoltage and undervoltage for the +3.3V rail or –5 V rail, depending on product option.
5	–12 V	Input for overvoltage and undervoltage for the –12 V rail. This function may disabled by tying this pin to a positive voltage above 2.4 V.
6	GND	Signal ground and silicon substrate.
7	HYST	Open collector output of the AC undervoltage comparator. A resistor between this pin and AC will provide hysteresis to the AC undervoltage sensing.
8	OFF	Pulling this pin low will reset the FAULT latch and discharge the start-up timing capacitors, UVB and PG CAP, allowing normal start-up for the system. Pulling this pin high will send the FAULT signal high, prompting a system shutdown.
9	AC	Non-inverting input to the AC undervoltage sensing comparator. If the AC pin is less than 2.5 V, POK goes low and UVB cap discharges.
10	PG CAP	A cap to ground provides a delay between undervoltage sensing becoming good and the POK output going high. Cap discharges whenever an output or AC undervoltage is detected.
11	POK	Open collector output of the undervoltage sensing comparators. This pin goes low upon an undervoltage condition. Except for the delay set by the PG CAP, this pin always reflects the actual state of the undervoltage sensing.
12	DELAY	A cap to ground will delay the FAULT signal when the OFF pin is used to shut down the system. The POK will signal a power fail warning immediately, but the FAULT shutdown of the power supply will be delayed.
13	UVB	A cap to ground provides start-up blanking of the undervoltage sensing portion of the FAULT signal. This pin may also be grounded to prevent undervoltage conditions from triggering the FAULT signal. This pin discharges the cap whenever AC goes low or FAULT pin goes high.
14	V_{REF}	2.5 V Voltage reference. This is a series regulator type reference.
15	FAULT	Open collector output of the overvoltage and undervoltage comparators.
16	CBD	Crow bar drive output of the overvoltage faults only.

Pin Function Description (For AS2316)

Pin Number	Function	Description
1	V_{CC}	Power input to the chip.
2	+12 V	Input for overvoltage and undervoltage for the +12 V rail.
3	+5 V	Input for overvoltage and undervoltage for the +5 V rail.
4	+3.3	Input for overvoltage and undervoltage for the +3.3V rail.
5	–5 V	Input for overvoltage and undervoltage for the –5 V rail.
6	–12 V	Input for overvoltage and undervoltage for the –12 V rail. This function may disabled by tying this pin to a positive voltage above 2.4 V.
7	GND	Signal ground and silicon substrate.
8	HYST	Open collector output of the AC undervoltage comparator. A resistor between this pin and AC will provide hysteresis to the AC undervoltage sensing.
9	OFF	Pulling this pin low will reset the FAULT latch and discharge the start-up timing capacitors, UVB and PG CAP, allowing normal start-up for the system. Pulling this pin high will send the FAULT signal high, prompting a system shutdown.
10	AC	Non-inverting input to the AC undervoltage sensing comparator. If the AC pin is less than 2.5 V, POK goes low and UVB cap discharges.
11	PG CAP	A cap to ground provides a delay between undervoltage sensing becoming good and the POK output going high. Cap discharges whenever an output or AC undervoltage is detected.
12	POK	Open collector output of the undervoltage sensing comparators. This pin goes low upon an undervoltage condition. Except for the delay set by the PG CAP, this pin always reflects the actual state of the undervoltage sensing.
13	DELAY	A cap to ground will delay the FAULT signal when the OFF pin is used to shut down the system. The POK will signal a power fail warning immediately, but the FAULT shutdown of the power supply will be delayed.
14	UVB	A cap to ground provides start-up blanking of the undervoltage sensing portion of the FAULT signal. This pin may also be grounded to prevent undervoltage conditions from triggering the FAULT signal. This pin discharges the cap whenever AC goes low or FAULT pin goes high.
15	V_{REF}	2.5 V Voltage reference. This is a series regulator type reference.
16	FAULT	Open collector output of the overvoltage and undervoltage comparators.

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{CC}	20	V
Continuous Power Dissipation at 25° C	P_D	1000	mW
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{STG}	–65 to 150	°C
Lead Temperature, Soldering 10 Seconds	T_L	300	°C

Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended Conditions

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{CC}	5 - 12	V

Typical Thermal Resistance

Package	θ_{JA}	θ_{JC}	Typical Derating
16L SOIC	65° C/W	45° C/W	10.0 mW/°C
16L PDIP	80° C/W	35° C/W	12.5 mW/°C

Electrical Characteristics

Electrical Characteristics are guaranteed over full junction temperature range (0 to 105° C). Ambient temperature must be derated based on power dissipation and package thermal characteristics. Unless otherwise specified, the conditions of test are V_{CC} = 12 V; +3.3 V = 3.3 V; +5 V = 5V; +12 V = 12 V; –12 V = –12 V; – 5 V = – 5 V; OFF = low.

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Bias						
Supply Current	I_{CC}	no faults		8	12	mA
Min. V_{CC} for operation	V_{CC} Min.	V_{REF} = 2.5 V, no faults			4.2	V
Undervoltage, Overvoltage +3.3 V (Not available on AS2350)						
+3.3 V Undervoltage	UV		2.87	2.95	3.03	V
+3.3 V Overvoltage	OV		3.76	3.86	3.96	V
+3.3 V Input Current	I_B	$V_{+3.3}$ =+3.3V, V_{+5} =+5.0V	-0.1	0	0.1	mA
+5 V						
+5 V Undervoltage	UV		4.40	4.50	4.60	V
+5 V Overvoltage	OV		5.74	5.89	6.04	V
+5 V Input Current	I_B	V_{+5} =+5.0V, $V_{+3.3}$ =+3.3V		1.6	2.5	mA
+12 V						
+12 V Undervoltage	UV		10.25	10.50	10.60	V
+12 V Overvoltage	OV		14.53	14.90	15.27	V
+12 V Input Current	I_B	V_{+12} =+12.0V		0.8	1.5	mA

Electrical Characteristics (cont'd)

Electrical Characteristics are guaranteed over full junction temperature range (0 to 105° C). Ambient temperature must be derated based on power dissipation and package thermal characteristics. Unless otherwise specified, the conditions of test are V_{CC} = 12 V; +3.3 V = 3.3 V; +5 V = 5V; +12 V = 12 V; –12 V = –12 V; – 5 V = – 5 V.

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
–5 V (Not available on AS2333)						
–5 V Undervoltage	UV		– 3.80	– 4.00	– 4.20	V
–5 V Overvoltage	OV		– 6.00	– 6.25	– 6.55	V
–5 V Input Current	I_B	V_{-5} =-5.0V		–80	–150	µA
–5 V Disable Voltage	V_D	Minimum voltage to disable		2.3	2.4	V
–12 V						
–12 V Undervoltage	UV		–9.20	–9.55	–9.80	V
–12 V Overvoltage	OV		–14.55	–15.04	–15.60	V
–12 V Input Current	I_B	V_{-12} =-12.0V		– 100	–200	µA
–12 V Disable Voltage	V_D	Minimum voltage to disable		2.0	2.2	V
AC/HYST						
AC Undervoltage	UV	T_J = 25° C	2.460	2.520	2.540	V
AC Input Current	I_B			– 0.5	–1	µA
HYST High State Leakage	I_L	V_{HYST} = 5 V; AC > 2.5 V		0.01	1	µA
HYST Output Current	I_{OL}	V_{HYST} = 0.3 V; AC < 2.5 V	1	3		mA
HYST Low Voltage	V_{OL}	I_{HYST} = 1 mA; AC < 2.5 V			0.3	V
Outputs						
POK High State Leakage	I_L	V_{POK} = 12 V; no faults		100	200	µA
POK Output Current	I_{OL}	V_{POK} = 0.4 V; V_{CC} = 7 V undervoltage condition	5	10		mA
FAULT High State Leakage	I_L	V_{FAULT} = 12 V; OFF = High		0.01	1	µA
FAULT Output Current	V_{OL}	V_{FAULT} = 0.4 V; no faults V_{CC} = 12 V V_{CC} = 5 V	 3 1.3	 10 4		 mA mA
CBD (Crow Bar Drive) Minimum Output Current	I_{OH}	overvoltage condition	– 25	–35		mA
CBD Output High Voltage	V_{OH}	I_{CBD} = 0 mA; T = 25 ° C I_{CBD} = 0 mA; T = 105 ° C; overvoltage condition	2.0 1.4	2.5	3.0 3.3	V V
CBD Pulldown Resistance	R_{OUT}	I_{CBD} = 1 mA; no faults	300	500	1000	1000

Electrical Characteristics (cont'd)

Electrical Characteristics are guaranteed over full junction temperature range (0 to 105° C). Ambient temperature must be derated based on power dissipation and package thermal characteristics. Unless otherwise specified, the conditions of test are V_{CC} = 12 V; +3.3 V = 3.3 V; +5 V = 5V; +12 V = 12 V; –12 V = –12 V; – 5 V = – 5 V.

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Voltage Reference						
Output Voltage	V_{REF}	I_{REF} = 0 mA, T_J = 25° C	2.488	2.500	2.525	V
Line Regulation	ΔV_{REF}	V_{CC} = 5 V to 15 V		10	15	mV
Load Regulation	ΔV_{REF}	I_{REF} = 0 V to –5 mA		10	15	mV
Temperature Deviation*	ΔV_{REF}	0 < T_J < 105° C		10	15	mV
Start-Up Functions						
UVB Pull-up Current Source	I_{OH}	V_{UVB} = 2.0 V; no faults	– 0.4	–1	–1.9	µA
UVB Clamp	$V_{OH\ MAX}$	I_{UVB} = 10 µA; no faults	2.9	3.1	3.3	V
UVB Discharge Current (AC shutdown)	I_{UVB}	V_{UVB} = 2.0 V; FAULT = low; AC < 2.5 V	3	8		mA
UVB Discharge Current (FAULT shutdown)	I_{OL}	V_{UVB} = 2.0 V; FAULT = high; AC > 2.5 V	2.5	10		mA
UVB Low Output Voltage	V_{OL}	I_{UVB} = 100 µA; FAULT = low; AC < 2.5 V			0.2	V
PG CAP Pull-up Current Source	I_{OH}	V_{PGCAP} = 2.0 V; no faults	– 0.5	–1	–1.4	µA
PG CAP Clamp	$V_{OH\ MAX}$	I_{PGCAP} = 10 µA; no faults; AC > 2.5 V	2.9	3.1	3.3	V
PG CAP Discharge Current	I_{OL}	V_{PGCAP} = 2.0 V; undervoltage condition	2	6		mA
PG CAP Low Output Voltage	V_{OL}	I_{PGCAP} = 100µA; undervoltage condition			0.2	V
OFF Input High Voltage	V_{IH}		2.0			V
OFF Input Low Voltage	V_{IL}				0.8	V
OFF Pull-up to V_{CC}	R	V_{OFF} = 0 V	25	50	100	kΩ
DELAY Pull-up Current Source	I_{OH}	V_{DELAY} = 0 V; OFF = high	– 0.5	–1	–2.0	µA
DELAY Clamp	$V_{OH\ MAX}$	I_{DELAY} = 10 µA; OFF = high	2.9	3.1	3.3	V
DELAY Discharge Current	I_{OL}	V_{DELAY} = 2.0 V; OFF = low	2.5	10		mA
DELAY Low Output Voltage	V_{OL}	I_{DELAY} = 100µA; OFF = low			0.2	V

*Temperature deviation is defined as the maximum deviation of the reference over the given temperature range and does not imply an incremental deviation at any given temperature.

Typical Performance Curves

Not Available at Time of Publishing

Theory of Operation

The AS23xx performs housekeeping functions for power supplies, especially switching power supplies for personal computers. The chip resides on the secondary side of the power supply (PSU), and it performs three primary functions:

1) monitors the output voltages and reports faults

2) sequences the start-up of the PSU

3) sequences the shutdown of the PSU

Section 1 - Output Voltages and Faults

1.0 Output Voltage Monitoring

The AS23xx monitors the standard voltage outputs for PC type power supplies. It has inputs for +12 V, +5 V, +3.3 V, -5 V and -12 V. These inputs are tied directly to the outputs of the PSU, and therefore do not require external dividers to set the error thresholds. These pins are monitored for both overvoltage (OV) and undervoltage (UV) conditions. The spec's for these thresholds are listed in the data sheet.

1.1 Overvoltage Faults: FAULT and CBD

An overvoltage condition in a power supply is considered to be a catastrophic and dangerous condition which must result in a safe, complete and near-instantaneous shutdown of the system. Overvoltages most often result from a break in the system feedback and control circuitry or from a short between outputs. When the AS23xx detects an overvoltage, the fault is latched internally, and the FAULT and CBD pins go high. The FAULT pin is an open collector NPN output which is intended to drive an optocoupler LED for feedback to the primary side controller of the PSU. The CBD pin is an NPN Darlington output which is intended to drive an SCR crowbar circuit which will short circuit the outputs of the PSU. Usually, just one or the other output is used depending on the PSU's cost and system definition. Both methods are intended to protect the customer's system, and the customer, as the first priority.

1.2 Undervoltage Faults: POK and FAULT

An undervoltage condition is sometimes not considered a catastrophic or dangerous condition, but always one which the customer should be warned about. The POK signal is a logic line to the customer's system that is specified in most PC type power supply systems. The AS23xx will pull the POK signal low when a UV fault is detected. A UV fault may or may not require the system to shut down, so an undervoltage blanking pin is provided (UVB). Grounding this pin will prevent UV faults from propogating to the FAULT pin. CBD does not react to UV faults.

1.3 Input Undervoltage: AC and HYST

In addition, there is a special undervoltage detection input for sensing the input voltage to the power supply, designated as the AC pin. This pin will cause the POK pin to go low if there is insufficient voltage to run the PSU outputs. Since power supplies must maintain high voltage isolation between the primary and secondary sides of the system, the AC pin is usually tied to a divided down and filtered representation of the secondary side switching waveform. Hysteresis for this function, to provide immunity from line ripple, is configured by the PSU designer and is implemented with the HYST pin, which is an open collector output of the AC comparator.

Section 2 - PSU Start-up Sequences

2.0 System Start-up Sequence

When the power supply starts up, the AS23xx must not erroneously report a FAULT. In addition, most PC type power supply specifications

require a specific timing sequence for the POK signal. Some PSU systems also require an isolated, low voltage, low power remote turn-on switch, rather than a large line cord switch.

2.1 VREF Enable of Chip Bias

Since the VCC of the AS23xx comes up in a finite amount of time, and since the VREF of the chip and the bias for the comparators are not within specification until approximately 4.2 V of VCC is available, the comparators for OV and UV and most other functions are disabled until VREF is within spec. This prevents the false detection of a FAULT due to an erroneous VREF. Similarly, if VREF is too heavily loaded and gets pulled low out of spec, these functions will also shut off.

2.2 Blanking UV's During Start-up: UVB

As the power supply outputs come up, the undervoltage FAULTs must be blanked to allow the supply to complete its start-up. Putting a capacitor to ground on the UVB pin will allow the PSU designer to set a specific period of time during which undervoltages will not propogate to the FAULT pin. The UVB pin provides a 1 μA current source to charge the cap, and once the UVB pin charges above 2.5 V, the undervoltage sensing is enabled. UVB does not blank undervoltages to the POK pin. The UVB pin is clamped one diode above VREF, or about 3.1 V, allowing fast discharge of the capacitor when the system resets.

2.3 POK Bias

The POK pin has some specific requirements based on industry standard PC power supply specifications. At start-up, the POK pin must not rise above 0.4 V. The POK pin is an NPN open collector whose base is tied to VCC via a simple resistor. Therefore, once VCC pulls above one diode or about 0.6 V, the POK pin will go low and saturate. If the POK pin external pull-up is to the 5 V output, the POK signal will not go above 0.4 V if the VCC of the AS23xx is tied to the 12 V output or an auxilliary rail.

2.4 POK Start-up Timing: PGCAP

In addition to 2.3 above, most PC power supplies require the POK pin to remain low until all outputs have been good for at least 100 ms but not more than 500 ms. A cap to ground on the PGCAP pin allows to the PSU designer to set the timing delay between the PSU outputs becoming good and the POK pin going high. The PGCAP pin provides a 1 μA current source to charge the cap, and when the cap charges above 2.5 V, the POK pin goes high. When an undervoltage occurs, the PGCAP pin discharges rapidly and the POK pin goes low. The POK pin does not respond to overvoltages.

2.5 Isolated Remote On/Off Switching: OFF and FAULT

A low voltage, isolated remote on/off switch may be implemented with the AS23xx OFF pin. If the chip VCC is run off an auxilliary rail, the FAULT signal may be used to start and stop the PSU. When the OFF pin is pulled from high to low or grounded, the FAULT pin resets to a low state, which may be used to drive an optocoupler to enable the primary side PWM controller. Allowing the OFF pin to go open circuit or high causes the POK pin to go low immediately, and the FAULT pin will go high after a time delay set by a cap to ground on the DELAY pin. This allows the customer's system to receive a POK warning before the PSU actually shuts down.

Section 3 - PSU Shutdown Sequences

3.0 Shutdown Sequence

For normal shutdowns, the primary requirement is that the POK signal should go low some minimum time before the PSU outputs fall out of spec.

3.1 Delaying Remote OFF: DELAY

In systems which use the OFF and FAULT pins to provide remote on/off switching, the delay between the OFF pin going high and the FAULT signal going high is programmable with a capacitor to ground on the DELAY pin as described in 2.5 above. The POK pin, on the other hand will go high immediately after the OFF pin is open circuited or pulled high, giving the system warning of the impending shutdown. The DELAY pin provides a 1 µA current source to charge the cap, and when the cap charges above 2.5 V, the FAULT pin will go high.

3.2 AC Warning Prior to Primary Drop-out

In systems where the input line voltage is switched, the AC pin threshold should be set so that it causes POK to go low before the primary bulk voltage reaches drop-out and the primary PWM shuts off. The output of the AC comparator also causes the UVB pin to pull low, so that the undervoltage sensing does not trip the FAULT latch as the outputs fall below spec. Recall that the AC pin senses a divided down and filtered representation of the secondary side switching waveform, which will provide a proportional representation of the primary voltage via the turns ratio of the transformer.

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