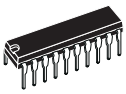
TSM111

TRIPLE VOLTAGE AND CURRENT SUPERVISOR

- OVERVOLTAGE PROTECTION FOR 3.3V, 5V AND 12V WITHOUT EXTERNAL COMPONENTS
- OVERCURRENT PROTECTION FOR 3.3V, 5V AND 12V WITH INTERNAL THRESHOLD VOLTAGE
- POWER GOOD CIRCUITRY
- GENERATES POWER GOOD SIGNAL
- REMOTE ON/OFF FUNCTION
- PROGRAMMABLE TIMING FOR POWER GOOD SIGNAL
- 14.5V TO 36V SUPPLY VOLTAGE RANGE
- TWO 1.6% VOLTAGE REFERENCES FOR MAIN AND AUXILIARY CONVERTER REGULATION LOOPS



N
DIP20
(Plastic Package)

D
SO20
(Plastic Micropackage)

ORDER CODE

Part Number	Temperature Range	Package	
		N	D
TSM111C	0, +70°C	•	•
Example : TSM111CD			

N = Dual in Line Package (DIP)
D = Small Outline Package (SO) - also available in Tape & Reel (DT)

DESCRIPTION

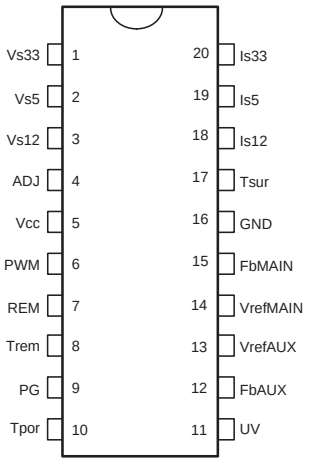
The TSM111 integrated circuit incorporates all sensing circuit to control a triple output power supply. It includes voltage references , comparators and matched resistors bridge for overcurrent and overvoltage detection without the need of any external components. Timing generator with external capacitors, control turn On and Off delays. It provides an integrated and cost effective solution for simultaneous multiple voltage control.

APPLICATION

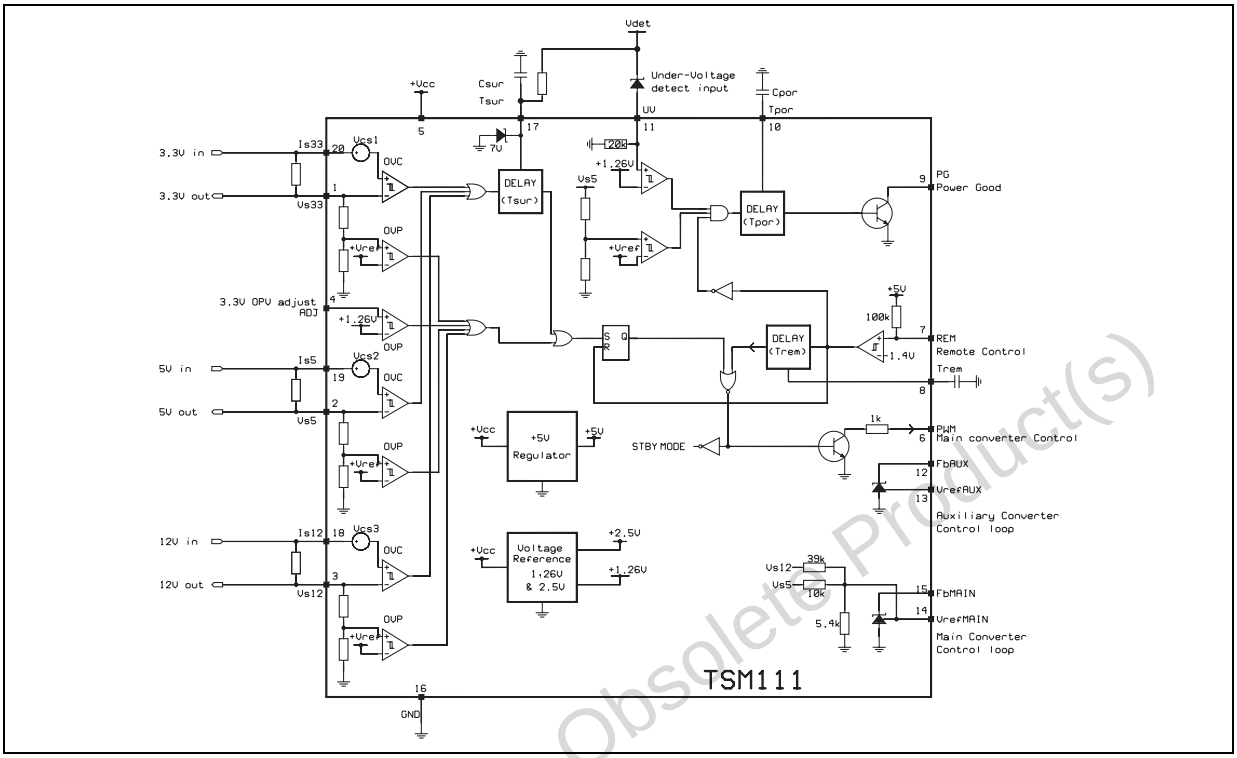
This circuit is designed to be used in SMPS for Desktop PC, to supervise currents and voltages of all outputs and generate power good information to the system while managing all timing during transitory operation.

The IC also manages the standby mode of SMPS while the PC is in sleep mode.

PIN CONNECTIONS (top view)



SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	DC Supply Voltage pin 5 [1)]	44	V
I_{out}	Output Current Power Good and PWM	30	mA
P_d	Power Dissipation	1	W
T_{stg}	Storage Temperature Range	-55 to +150	°C
ESD	Electrostatic Discharge	2	kV
I_{in}	Input Current	50	mA
V_{ter}	Minimum voltage on all pins with respect to ground terminal	-0.3	V
I_1	Maximum continuous current in all pins (except pin 5)	±10	mA
I_2	Max peak current in all pins for latch-up free operation	±200	mA

1. All voltages values, except differential voltage are with respect to network ground terminal.

OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{CC}	DC Supply Voltage pin 5 [1)]	15 to 36	V
T_{oper}	Operating Free Air Temperature Range	0 to +70	°C
I_k	Operating Cathode Current, Vrefaux and Vrefmain	30	mA

1. The DC supply voltage must be higher than the maximum voltage applied on the 3.3, 5, 12V inputs (Is3.3, Is5, Is12) plus 2V. For example, if 13.2Vis present on the Is12 input, the minimum required value on V_{CC} is 15.2V.

ELECTRICAL CHARACTERISTICS

V_{CC} = 16V, T_{amb} = 0°C to 70°C (typical values given for 25°C)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
I_{CC}	Total Supply Current	PG low		5	10	mA
V_{cs1}	Current Sense Threshold Voltage 3.3V		46.5	50	53.5	mV
V_{cs2}	Current Sense Threshold Voltage 5V		46.5	50	53.5	mV
V_{cs3}	Current Sense Threshold Voltage 12V		60.5	65	69.5	mV
V_{iscm}	Current Sense Input Common Mode Voltage Range	see note 2	0		VCC -2	V
V_{vs1}	Overvoltage Sense 3.3V		3.8	4	4.2	V
V_{vs2}	Overvoltage Sense 5V		5.8	6.1	6.4	V
V_{vs3}	Overvoltage Sense 12V		13.4	14.2	15	V
V_{Adj}	Threshold Voltage, 3.3V OVP Projection ADJ Input pin 4		1.22	1.26	1.3	V
V_{sur}	Thereshold Voltage (T_{sur} input)		2.4	2.5	2.6	V
T_{sur}	T_{sur} Timing with Determined External Components	33kΩ to VCC, 4.7µF to ground		21		ms
V_{surend}	Tsur Input Clamp Voltage			7	8	V
V_{pull}	Input Pulled Down Voltage for V33, V5 and V12	I_{sink} = 100µA, REMOTE high			0.4	V

VOLTAGE REFERENCE, AUXILIARY CONVERTER (Fbaux)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{refaux}	Reference Voltage	I_r = 0.5mA, T_{amb} = 25°C	2.46	2.5	2.54	V
I_{aux}	Current Stability	I_r = 0.5mA to 10mA			20	mV
T_{aux}	Temperature Stability				17	mV
$R_{egliaux}$	Line Regulation	15 < V_{CC} < 36V		1		mV/V
I_{outaux}	Output Sinking Current Capability	V_{out} > 2V	15	25		mA

VOLTAGE REFERENCE, MAIN CONVERTER (Fbmain)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_{refmain}$	Reference Voltage	I_r = 0.5mA, T_{amb} = 25°C	2.46	2.5	2.54	V
I_{main}	Current Stability	I_r = 0.5mA to 10mA			20	mV
T_{main}	Temperature Stability				17	mV
$R_{eglimain}$	Line Regulation	15 < V_{CC} < 36V		1		mV/V
$I_{outmain}$	Output Sinking Current Capability	V_{out} > 2V	15	25		mA
Resp	Absolute Precision of the Internal Resistor Connected to $V_{refmain}$ (39k, 10k, 5.4k)			±15		%
Resm	Matching of the Internal Resistors Connected to $V_{refmain}$ (39k, 10k, 5.4k)			±1		%

POWER GOOD SECTION

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Tpor	Turn on Delay for Power Good, Cpor = 2.2µF	Ic = 20µA typ., Vth = 2V typ.	100	300	500	ms
Ic	Tpor Delay Charging Current		12	20	28	µA
Vth	Tpor Delay Threshold Voltage		1.8	2	2.2	V
Vhdet	Under Voltage Comparator Hysteresis		20	40	80	mV
Vhpor	Hysteresis on Tpor		200	250		mV
Vdet	Voltage Detect Level UV Input pin 11		1.22	1.26	1.3	V
Rdet	Load Resistor on Vdetect UV Input pin 11			20		kΩ
Vvs4	Undervoltage Sense 5V		4.1	4.3	4.5	V
tr	PG Output Rise Time	C_L = 100pF		1		µs
tf	PG Output Fall Time	C_L = 100pF		300		ns
Vol2	Power Good Output Saturation Level	Ic = 15mA			0.4	V
Ioh2	Power Good Leakage Current Collector	V_{out} = 5V			1	µA

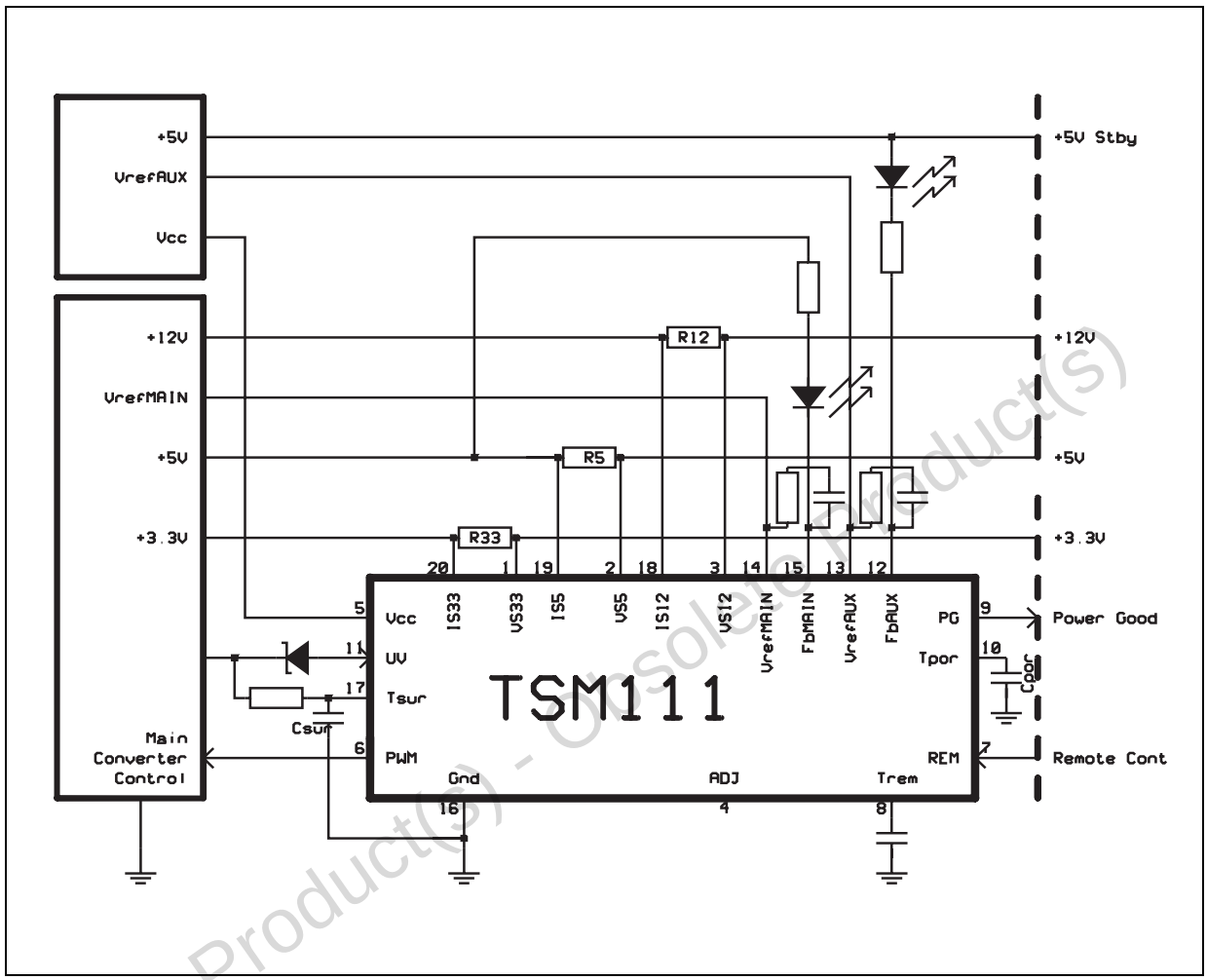
REMOTE On/Off

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Vrem	Remote On/Off Input Threshold Level		1		1.8	V
Iil	Remote Input Low Driving Current				1	mA
Vol1	Remote Ouput (PWM) Saturation Level	Ic = 0.5mA			1.3	V
Ioh1	Remote Output (PWM) Collector Leakage Current	Vout = 5V			1	µA
Vih1	Remote Input Voltage Level	Pin 7 open	4.2		5.25	V
Trem1	Timing On to Off in to On/Off out, Cext = 100,F		4	8	14	ms
Trem2	Timing Off to On in to On/Off out, Cext = 100nF		16	24	34	ms

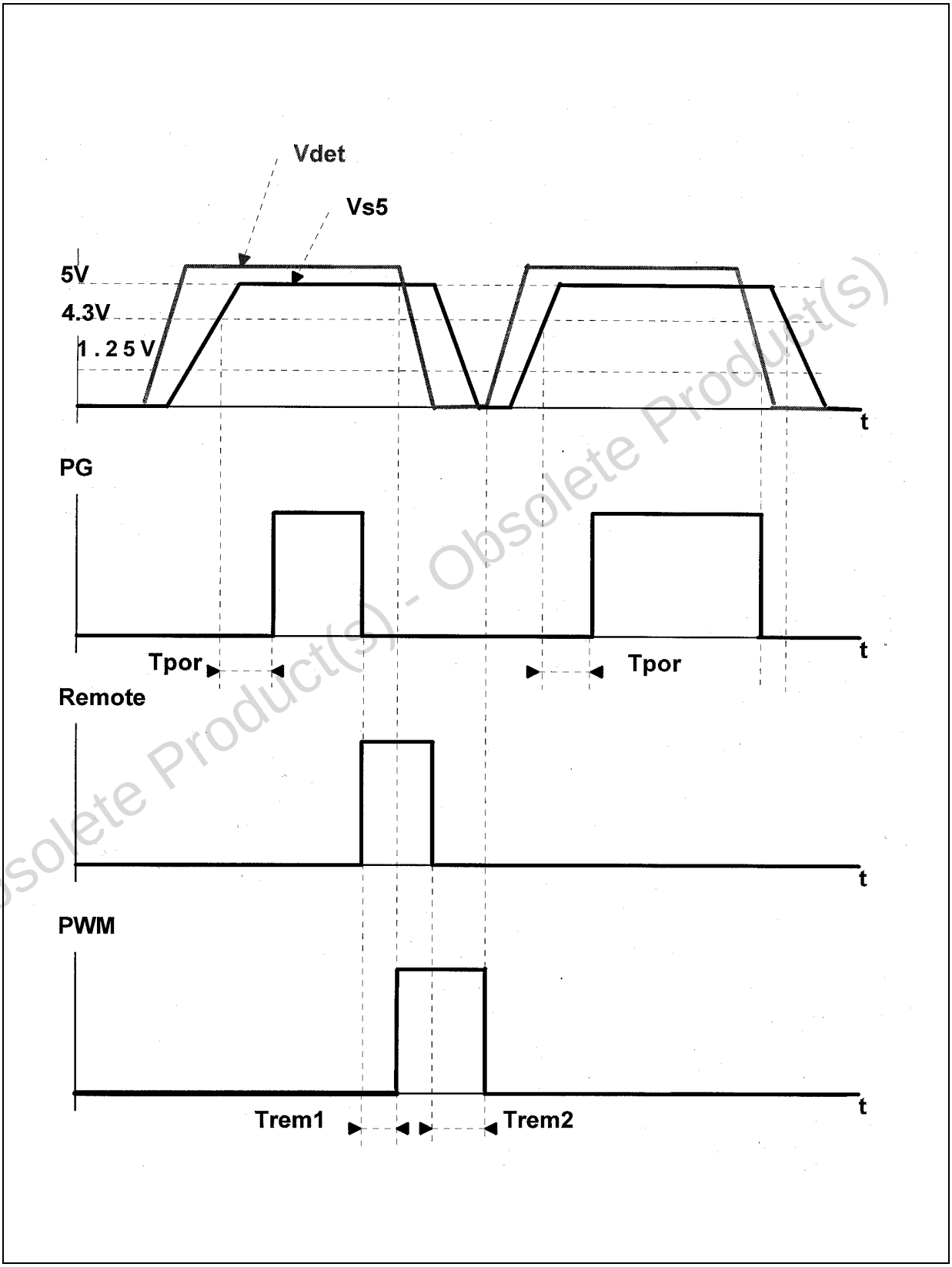
PIN DESCRIPTION

Name	Pin	Type	Function
Vcc	5	supply	Positive supply voltage. The DC supply voltage must be higher than the maximum voltage applied on the 3.3, 5, 12V inputs (Is3.3, Is5, Is12) plus 2V. For example, if 13.2V is present on the Is12 input, the minimum required value on VCC is 15.2V
Vrefmain	14	analog input	Reference comparison input for main converter regulation loop. 2.5V ±1.6%
Fbmain	15	analog output	Output for main converter regulation loop (optocoupler)
Vrefaux	13	analog input	Reference comparison input for auxiliary converter regulation loop. 2.5V ±1.6%
Fbaux	12	analog output	Output for auxiliary converter regulation loop (optocoupler)
IS33	20	analog input	3.3V overcurrent control sense input.
V33	1	analog input	3.3V overvoltage control sense input.
IS5	19	analog input	5V overcurrent control sense input.
V5	2	analog input	5V overvoltage control sense input.
IS12	18	analog input	12V overcurrent control sense input.
V12	3	analog input	12V overvoltage control sense input.
Adj	4	ana input	Adjustment pin for 3.3V OVP. This pin is to be used for an OVP other than 3.3V (eg for µC power supply = 2.7V). When not in use, this pin should be grounded. When in use, VS33 should not be connected.
Tsur	17	program. analog input	Overcurrent blank-out time 20 to 30ms settable through external RC. The voltage at this pin is clamped at typically 5V. Trip voltage = 1.25V.
Rem	7	logic input	Remote On/Off logic input for µC, turn off PWM after Trem delay. Rem = 0 means that the main SMPS is operational.
Trem	8	program. analog input	Connected to external capacitor to determine Trem (remote control delay) timing. Trem (on to off) is 8ms typ. Trem (off to on) is 24ms typ. Crem = 0.1µF
PWM	6	logic output	Output signal to control the primary side of the main SMPS through an opto-coupler. When PWM is low, the main SMPS is operational.
Tpor	10	program. analog input	Connected to external capacitor for Power-on-reset timing. Cpor = 2.2µF
UV	11	analog input	Undervoltage detection, control and detect main AC voltage failure.
PG	9	logic input	Power Good logic output, 0 or 5V. Power Good high (=1) means that the power is good for operation.
GND	16	supply	Ground or Negative supply voltage.

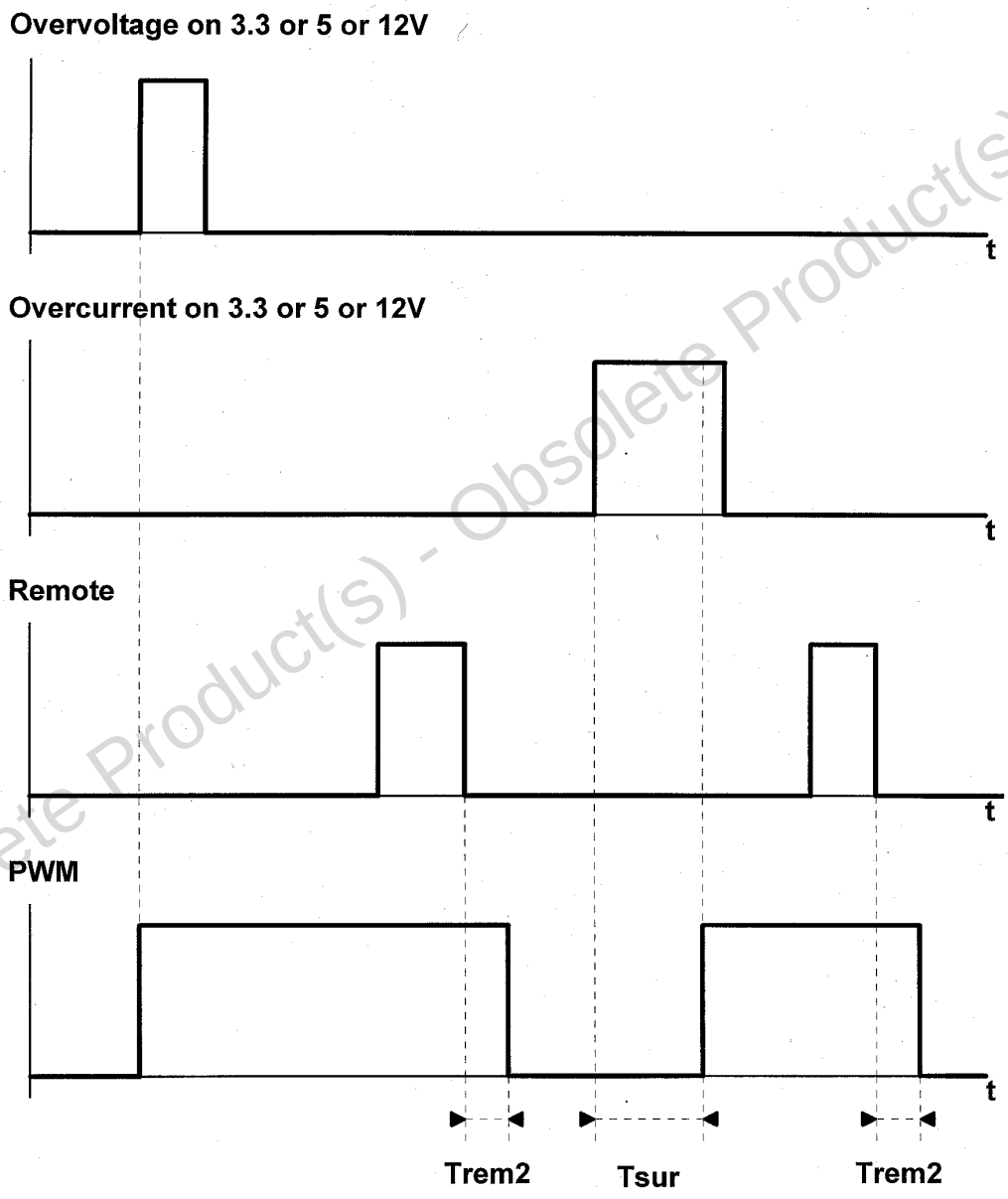
APPLICATION DIAGRAM



TIMING DIAGRAM : remote control



TIMING DIAGRAM : overvoltage or overcurrent shut-down



AN EXAMPLE OF 90W MICRO ATX POWER SUPPLY USING L5991A, VIPER20 AND TSM111

Protection against accidental short circuits and fault conditions is mandatory in PC power supplies. These protection circuits can be realized by using many discrete components which occupy a lot of PCB space, design time in fine tuning the circuit and also add to assembling costs.

ST's single chip TSM111 IC provides complete protection circuits design easier, with fewer number of components. TSM111 is an ideal supervisor IC for PC power supplies.

The salient features and benefits of this device are listed below :

a) Over voltage protection for 3.3V, 5V and 12V without external component.

b) Over current protection for 3.3V, 5V and 12V.

c) Generates Power Good signal.

d) Programmable timing for Power Good signal.

e) Wide range supply operating voltage up to 36V (44V AMR).

f) Stable internal voltage reference.

g) Two 1.6% voltage reference for Main and Auxiliary regulation.

h) Few external components.

i) Circuit occupies little space on PCB.

j) Easy implementation of the circuit.

FEATURE DESCRIPTIONS

a) Over voltage protection can be implemented without any additional components. Overvoltage sense levels for 3.3V, 5V, 12V are 4V, 6.1V, 14.2V respectively. With very little tolerances, better protection is achieved.

b) Over current protection can be implemented with very small value sense resistors. As the current sense threshold levels are set very low, regulation is not affected. The current sense threshold levels for 3.3V, 5V, 12V are 50mV, 50mV and 65mV respectively.

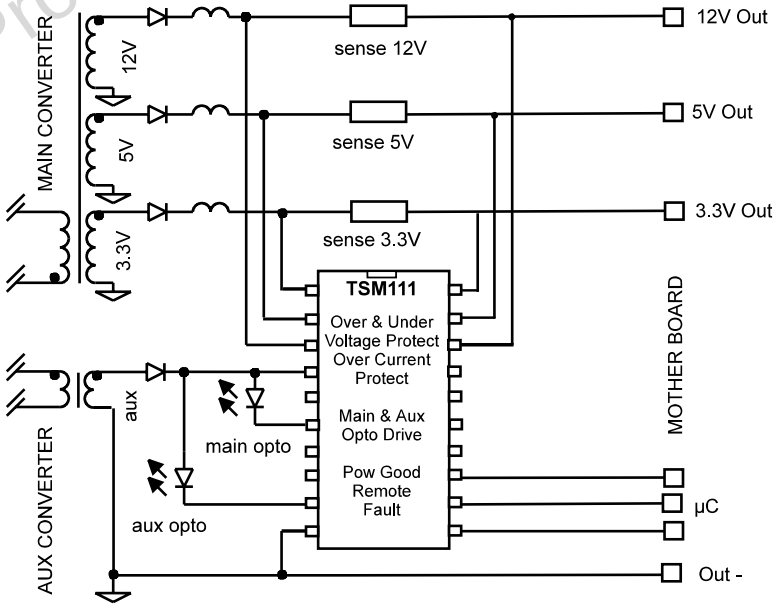
c) The power good signal (pin9) is asserted to indicate the 5V and 3.3V is above the under voltage threshold level. PG pin goes high when the above condition is reached. Pull up resistor R27 (3.1K) is connected to 5V STDBY supply from this pin.

d) The timing of the power good signal can be controlled by adjusting the value of the charging capacitor on pin 10. With 2.2µF/16V capacitor on pin 10, 400msec turn on delay is achieved.

e) The power supply can be operated from 14.5V to 36V. The VCC must always be higher than the supply voltage on the 12V input pin by 2V .i.e. if 14V is appearing 12V input pin the Vcc must be > 16V.

f) Two internal high precision TL431 shunt regulators are built-in. It provides stable reference voltages with a voltage precision of 1.6%.

COMPLETE PC SMPS
SECONDARY SUPERVISOR



SUPERVISORY CIRCUIT OPERATION

The system power ON/OFF logic is generated by the PC, which is “Low” in system “On” condition and “High” when the system is “Off”. This is connected to remote pin 7.
The IC’s internal logic circuit generates a control signal on pin 6. In normal operation, when there is no over voltage or over current at the three inputs, the voltage on pin 6 follows the Remote pin 7 voltage, i.e. if the remote pin 7 is low the pin 6 is also low or vice versa.
When fault is detected on the inputs, control pin 6 goes “High”. This control pin 6 output can be used to turn off the Mains Power Supply during fault condition. An optocoupler is connected directly, with cathode connected to the IC pin 6 and anode to 5V (from STDBY supply).

In normal operation the voltage on pin 6 is (opto cathode) is around 3.7 V. On the primary side the opto transistor collector is pulled through a resistor to Vref.

It is required to invert the signal before connecting to the feedback compensation pin 6 of L5991A for reverse logic. i.e during normal operation the compensation pin is not affected and during fault condition the pin is pulled Low. Slight delay (R34,C32) is introduced on the primary side to avoid fault turn on condition.

N**ote :** Once the fault condition is removed, it is required to reset the Remote pin to make the system function again.

BILL OF MATERIAL

The following are the bill of material for the 90W SMPS :

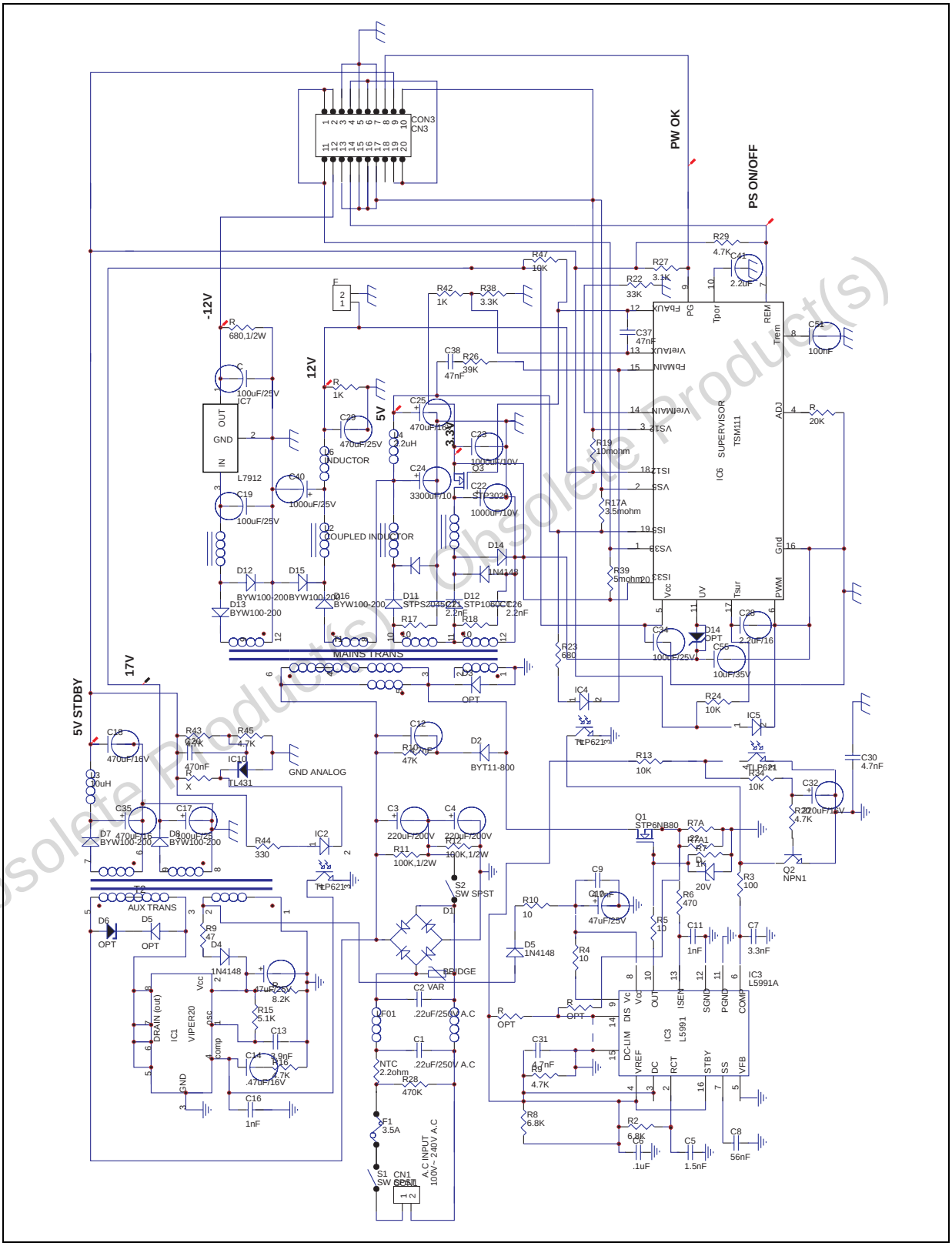
No	Part Number	Qt	Manufacturers	Remarks / Descriptions
ICs				
1	L5991A	1	ST	Advanced PWM Controller
2	VIPer20 DIP	1	ST	Aux controller PWM+Mos
3	TSM111	1	ST	Triple Voltage and Current Supervisor
4	LM7912CV	1	ST	-12V Post Regulator
5	TL431	1	ST	Programmable Voltage Reference
MOSFETS				
6	STP6NB80	1	ST	TO220 6A, 800V Mos
7	STP3020L	1	ST	TO220 22mohm 33V Mos
Rectifiers				
8	BYV10-40	1	ST	1A, 40V or BYV10-60 or BYW100-200
9	BYW100-200	3	ST	1A, 100V or 200V, BYW100-100
10	STPS20L40CT	1	ST	2x10A, 40V or STPS2045CT or STPS30L40CT
11	STSPS10L40CT	1	ST	2x5A, 40V
12	KAL04	1	-	3Amp 400VAC Bridge Rectifier or higher
13	1N4148	1	-	
Transformers / Inductors				
12	HM00-98 150	1	BI Tech. **	Aux Transformer
13	HM00-98151	1	BI Tech.	Main Transformer
14	HM00-98 148	1	BI Tech.	Coupled inductors
15	HM50-150K	1	BI Tech.	15uH inductors - output filter
16	HM11-51502	1	BI Tech.	2.2uH inductors - output filter
17	HM28-32022	1	BI Tech.	Common Mode choke - AC input filter
18	10uH	1	-	10uH inductors - output filter
Connectors				
19	AC input conn	1	-	
20	20-pin conn: 39-02-2200	1	Molex	20 pin output connector with terminals Molex 39-00-0038
21	Fann connector	1	-	
22	Fuse 3.5A	1	-	
23	NTC	1	Siemens	2.2 ohm
24	TLP621 Optocoupler	3	Toshiba	100% transfer ratio
25	AC switch	1	-	
26	115V-23oV selector	1	-	

... continued BILL OF MATERIAL

No	Part Number	Qt
Capacitors		
27	47UF/25V	1
28	3.9NF	1
29	.47UF/16V	1
30	1NF	2
31	100UF/25	1
32	.22UF/250V A.C	2
33	1000UF/10V	2
34	3300UF/10	1
35	470UF/16V	2
36	2.2NF	2
37	2.2UF/16	1
38	470UF/25V	1
39	4.7NF	4
40	47UF/16V	1
41	100UF/25V	3
42	100UF/25V	1
43	47NF	3
44	220UF/200V	2
45	1000UF/25V	1
46	2.2UF	1
47	1.5NF	1
48	10NF	1
49	.1UF	1
50	3.3NF	1
51	56NF	1

No	Part Number	Qt
Resistors		
52	20K	1
53	47K,3W	1
54	100K,1/2W	2
55	5.1K	1
56	3 MOHM	1
57	1OR	2
58	10 MOHM	1
59	4.7K	5
60	68K	1
61	680R	1
62	39K	1
63	3.1K	1
64	470K	1
65	100R	1
66	10K	4
67	3.3K	1
68	5 MOHM	1
69	1K	1
70	330R	1
71	10,1/4W	2
72	470R	1
73	0.68	2
74	6.8K	2

** BI Technolo les Pte Lte
Phone No: 65 249-1115
Fax No: 65 445-1983
Attn: Kelvin Lim, Sales Dept


PW OK
PS ON/OFF
-12V
12V
5V
3.3V
17V
5V STDBY
MAINS TRANS
AUX TRANS
SUPERVISOR
TSM111
IC6
L7912
IC7
TL431
IC10
VIPER20
IC1
L5991
IC3
L5991A
BRIDGE
SW SPST
A.C INPUT
100V~ 240V A.C
GND ANALOG
OPT
BYT11-800
STP6NB80
STP3020
STPS2045CT
STP10NC50
1N4148
BYW100-200
Obsolete Product(s)

EVALUATION BOARD - TECHNICAL NOTE

TSM111 is a Housekeeping IC which is best used in PC Switch Mode Power Supplies for secondary 3.3V, 5V, and 12V power lines protection.
TSM111 integrates all the necessary functions for a secure and reliable overcurrent and overvoltage protection, as well as a logic interface for proper communication with the motherboard and adjustable timing circuitry for optimized sequencing management. Moreover, TSM111 integrates two precise shunt voltage references for direct optocoupler drive. TSM111, integrating the equivalent of more than 25 discrete components, saves a lot of design time and fine tuning, as well as PCB area, and increases the reliability of the whole application.

How to use the TSM111 Evaluation Board ?

This evaluation board allows to adapt the TSM111 housekeeping chip to an already existing PC Power Supply by simply choosing proper values for it's external components, and making the adequate connections to the I/O of the evaluation board.
The Electrical Schematic of the TSM111 evaluation board is shown on figure 1. It includes the TSM111 as well as the minimum component number required to make the TSM111 fit in a PC SMPS application.

Components calculations

The overvoltage protection is not to be adjusted. Internal voltage thresholds are given by Vvs1, Vvs2, Vvs3 for respective protection of the 3.3V, 5V, 12V power lines.
The overcurrent protection is given by the choice of the Sense resistors R1, R2, R3 (respectively for each power line 3.3V, 5V, 12V). Internal precise voltage thresholds define the tripping voltage drops for each line following equations 1, 2 & 3 :

$Vcs1 = R1 \times I33$ eq1

$Vcs2 = R2 \times I5$ eq2

$Vcs3 = R3 \times I12$ eq3

where I33, I5, and I12 are the tripping currents.
The system will latch (Fault output will be active - high) if the overcurrent lasts more than the authorized surge delay Tsur given by equations 4 & 5 :

$Icharge = Vcc / R4$ eq4

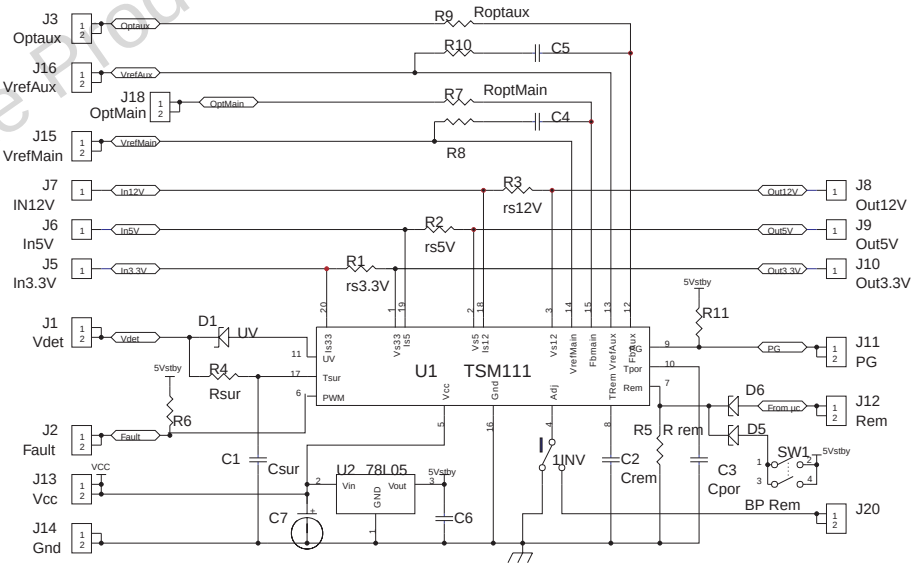
$Tsur = (C1 \times Vsur) / Icharge$ eq5

Note that eq4 is an approximation of a capacitive charge where Vcc (16V min) is large versus the threshold voltage Vsur (2.5V).

$R4=33k\Omega$, $C1=4.7\mu F$ => Tsur=21ms

Thanks to the Tsur adjustment, the normal surge currents which occur during power up (capacitive oads charging) are blanked for a time depending on each application.

EVALUATION BOARD - ELECTRICAL SCHEMATIC



When the system has latched (either after overcurrent or overvoltage condition), the system needs to be reset via the Remote input. The C2 capacitor determines two different timings to the Fault output :

C2=100nF => Trem1(ON to OFF)=8ms

C2=100nF => Trem2(OFF to ON)=24ms

R5 is a pull down resistor on the remote pin of TSM111. Note that an integrated pull up resistor of 100kΩ is to be taken into account in the choice of R5, knowing that the threshold voltage of the input comparator is 1.4V. Therefore, R5 should be lower than 38.8kΩ.

R5 = 1kΩ is a good value.

The evaluation board integrates the possibility to make the Remote signal either manual, or electronic thanks to the ORing diodes D5 and D6 (and the pull down resistor R5), and the Push Button (SW1). These diodes can of course be replaced by straps according to the evaluation requirements (manual or electronic).

The Tpor delay time allows the PG output (Power Good) to rise to high level when the 5V power line internal supervision circuitry has stayed above the undervoltage 4.3V threshold for more than Tpor time following the approximated equation 6 :

C3 x Vth = Ic x Tpor eq6

where Vth is 2V and Ic is 20µA.

C3=2.2µF => Tpor=300ms

When the 5V power line passes under the 4.3V undervoltage threshold, the Power Good signal (PG) falls immediately to low level.

The Power Good output can also be triggered by the Vdet input of the board. This input should be connected to a power line representative of the AC mains power situation. As an example, an additional winding on the auxiliary power supply offer an early warning of power down from the mains power point of view. The UV threshold is internally fixed to Vdet=1.26V. Therefore, it is necessary to add a zener diode D1.

D1=15Vzener => Vdet=16.26V

Note that a 20kΩ serial pull down resistor is integrated. Therefore, only a low power zener is needed.

The Fault output needs a pull up resistor R6.

The Power Good output needs a pull up resistor R11. Both signals are pulled up to the 5Vstandby power supply which can be generated from the evaluation board thanks to a 78L05 5V regulator. This regulator needs a C6 bypass capacitor.

The C7 bypass capacitor smoothens the VCC pin of TSM111.

The Adj (Adjust) pin should be connected to ground. Adjust allows to tune a new overvoltage protection value (ex 2.7V instead of 3.3V).

Example of component lists

Table 1 gives an example of component list

Name	Type	Value	Comment
U1	IC	TSM111	DIP20
U2	IC	78L05	TO92
R1	R 1/4W R 1/2W R 1W	10mΩ 5mΩ 2.5mΩ	5A 10A 20A
R2	R 1/4W R 1/2W R 1W	10mΩ 5mΩ 2.5mΩ	5A 10A 20A
R3	R 1/4W R 1/2W R 1W	65mΩ 13mΩ 6.5mΩ	1A 5A 10A
R4	R 1/4W	33KΩ	
R5	R 1/4W	1KΩ	
R6	R 1/4W	47KΩ	
R7	R 1/4W	depends on opto used	
R8	R 1/4W	10kΩ comp. network to be fine tuned	
R9	R 1/4W	depends on opto used	
R10	R 1/4W	10kΩ comp. network to be fine tuned	
R11	R 1/4W	47KΩ	
D1	Z 1/4W	15V	
D5	D 1/4W	1N4148	
D6	D 1/4W	1N4148	
C1	C Electro	4.7µF	
C2	C Plastic	100nF	
C3	C Electro	2.2µF	
C4	C Plastic	10NF comp. network to be fine tuned	
C5	C Plastic	10NF comp. network to be fine tuned	
C6	C Plastic	100nF	
C7	C Electro	10µF	

Figure 2a

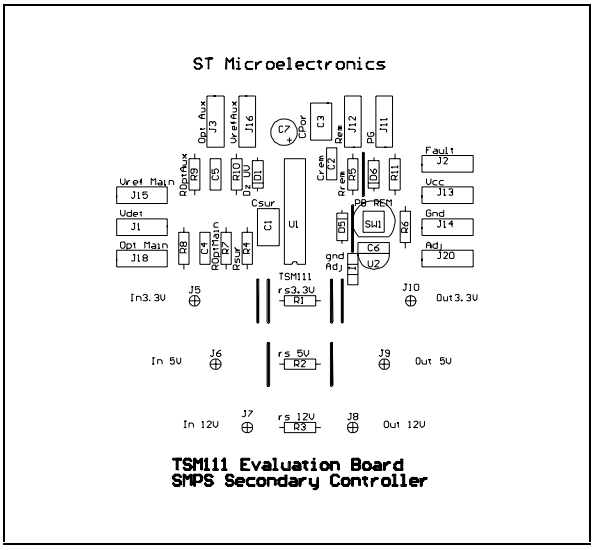
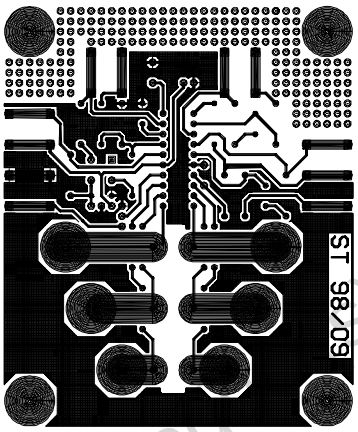
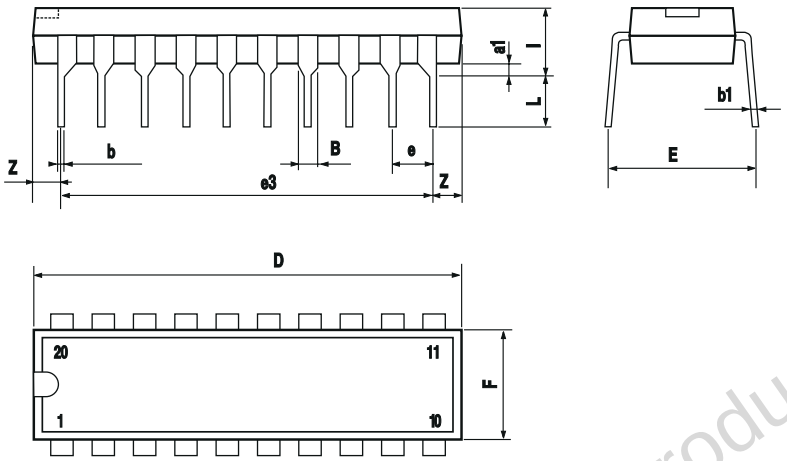


Figure 2b



PACKAGE MECHANICAL DATA

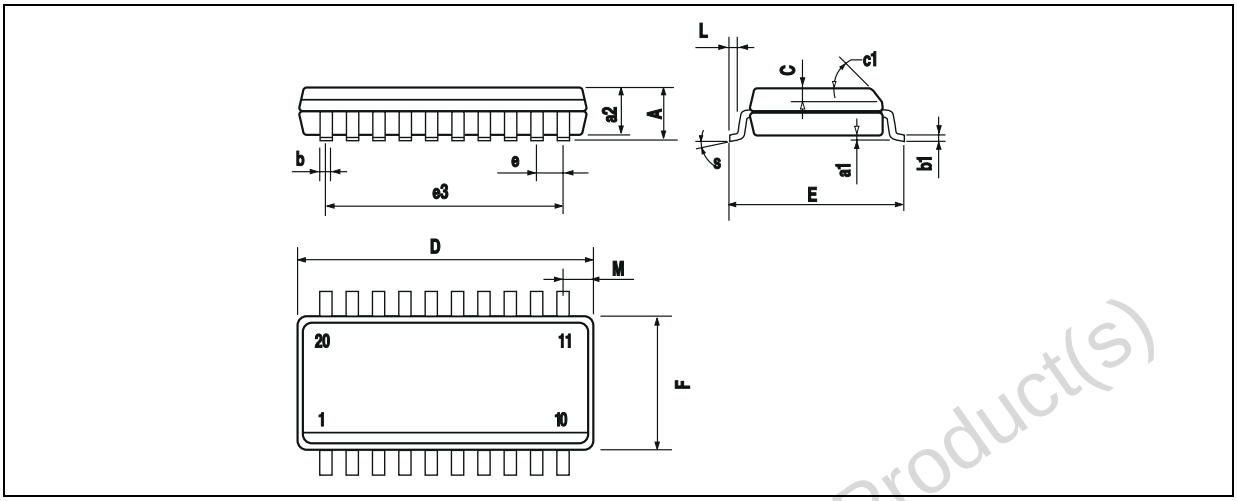
20 PINS - PLASTIC DIP



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.254			0.010		
B	1.39		1.65	0.055		0.065
b		0.45			0.018	
b1		0.25			0.010	
D			25.4			1.000
E		8.5			0.335	
e		2.54			0.100	
e3		22.86			0.900	
F			7.1			0.280
I			3.93			0.155
L		3.3			0.130	
Z			1.34			0.053

PACKAGE MECHANICAL DATA

20 PINS - PLASTIC MICROPACKAGE (SO)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			2.65			0.104
a1	0.1		0.3	0.004		0.012
a2			2.45			0.096
b	0.35		0.49	0.014		0.019
b1	0.23		0.32	0.009		0.013
C		0.5			0.020	
c1	45° (typ.)					
D	12.6		13.0	0.496		0.512
E	10		10.65	0.394		0.419
e		1.27			0.050	
e3		11.43			0.450	
F	7.4		7.6	0.291		0.299
L	0.5		1.27	0.020		0.050
M			0.75			0.030
S	8° (max.)					