



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



ORDER CODES

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

DESCRIPTION

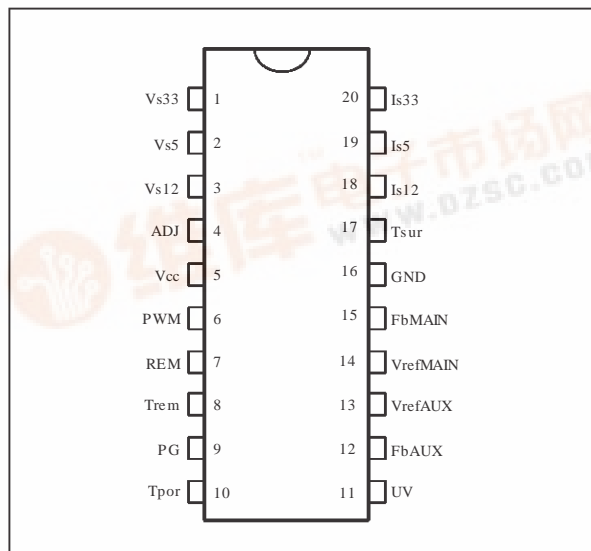
The TSM111 integrated circuit incorporates all sensing circuit to control a triple output power supply. It includes voltage references, comparators and matched resistors bridge for overcurrent and over-voltage detection without the need of any external components. Timing generator with external capacitors,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

APPLICATIONS

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.

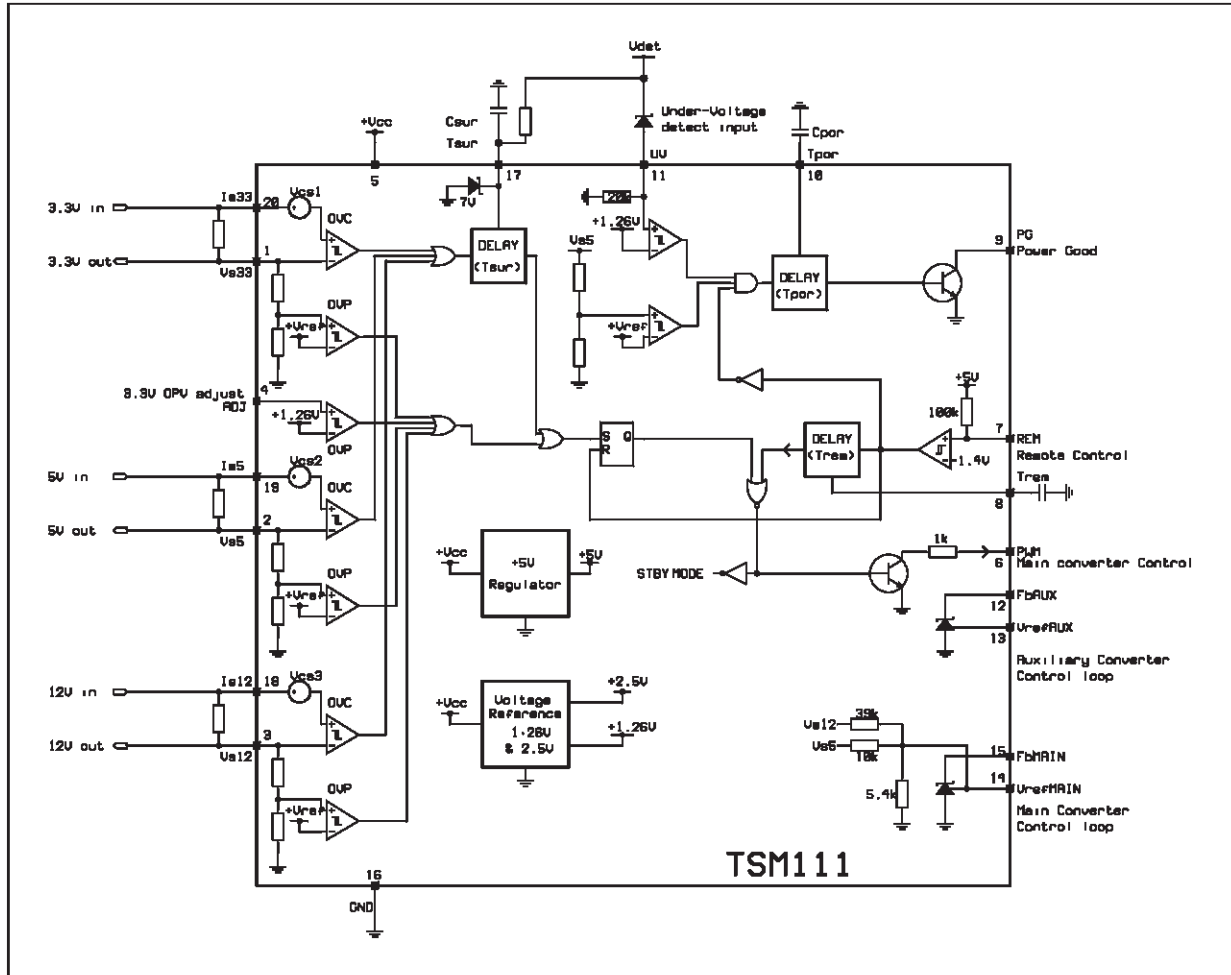
The IC also manages the standby mode of SMPS while the PC is in sleep mode.

PIN CONNECTIONS (top view)



TSM111

SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|------------------|-----------------------------------|-------------|------|
| V _{CC} | DC Supply Voltage pin 5 - note 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 |

Note : 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 - note 2 | 15 to 36 | V |
| T _{oper} | Operating Free Air Temperature Range | 0 to +70 | °C |
| I _k | Operating Cathode Current, V _{refaux} and V _{refmain} | 30 | mA |

Note : 2. The DC supply voltage must be higher than the maximum voltage applied on the 3.3, 5, 12V inputs (I_{s3.3}, I_{s5}, I_{s12}) plus 2V.
For example, if 13.2V is present on the I_{s12} input, the minimum required value on V_{CC} is 15.2V.



ELECTRICAL CHARACTERISTICS

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

| 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 | | $V_{CC} - 2$ | 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 Protection. ADJ input pin4 | | 1.22 | 1.26 | 1.3 | V |
| V_{sur} | Threshold voltage (Tsur input) | | 2.4 | 2.5 | 2.6 | V |
| T_{sur} | Tsur Timing with Determined External Components | 33k Ω to V_{CC} , 4.7 μ F to ground | | 21 | | ms |
| V_{surend} | Tsur Input Clamp Voltage | | | 7 | 8 | V |
| V_{pull} | Input Pulled Down Voltage for V33, V5 and V12 | Isink = 100 μ A, REMOTE high | | | 0.4 | V |

VOLTAGE REFERENCE, AUXILIARY CONVERTER (Fbaux)

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|--------------|-----------------------------------|---|------|------|------|------|
| V_{refaux} | Reference Voltage | $I_r = 0.5mA$, $T_{amb} = 25^{\circ}C$ | 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 |
| Reg_{iaux} | 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 | $I_r = 0.5mA$, $T_{amb} = 25^{\circ}C$ | 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 |
| Reg_{lmain} | 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 = 2.2 μ F | Ic = 20 μ A typ., Vth = 2V typ. | 100 | 300 | 500 | ms |
| Ic | Tpor Delay Charging Current | | 12 | 20 | 28 | μ A |
| 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 | | k Ω |
| Vvs4 | Undervoltage Sense 5V | | 4.1 | 4.3 | 4.5 | V |
| tr | PG Output Rise Time | CL = 100pF | | 1 | | μ s |
| tf | PG Output Fall Time | CL = 100pF | | 300 | | ns |
| Vol2 | Power Good Output Saturation Level | Ic = 15mA | | | 0.4 | V |
| Ioh2 | Power Good Leakage Current Collector | Vout = 5V | | | 1 | μ A |

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 Output (PWM) Saturation Level | Ic = 0.5mA | | | 1.3 | V |
| Ioh1 | Remote Output (PWM) Collector Leakage Current | Vout = 5V | | | 1 | μ A |
| Vih1 | Remote Input Voltage Level | Pin 7 open | 4.2 | | 5.25 | V |
| Trem1 | Timing On to Off in to On/Off out, Cext = 100nF | | 4 | 8 | 14 | ms |
| Trem2 | Timing Off to On in to On/Off out, Cext = 100nF | | 16 | 24 | 34 | ms |



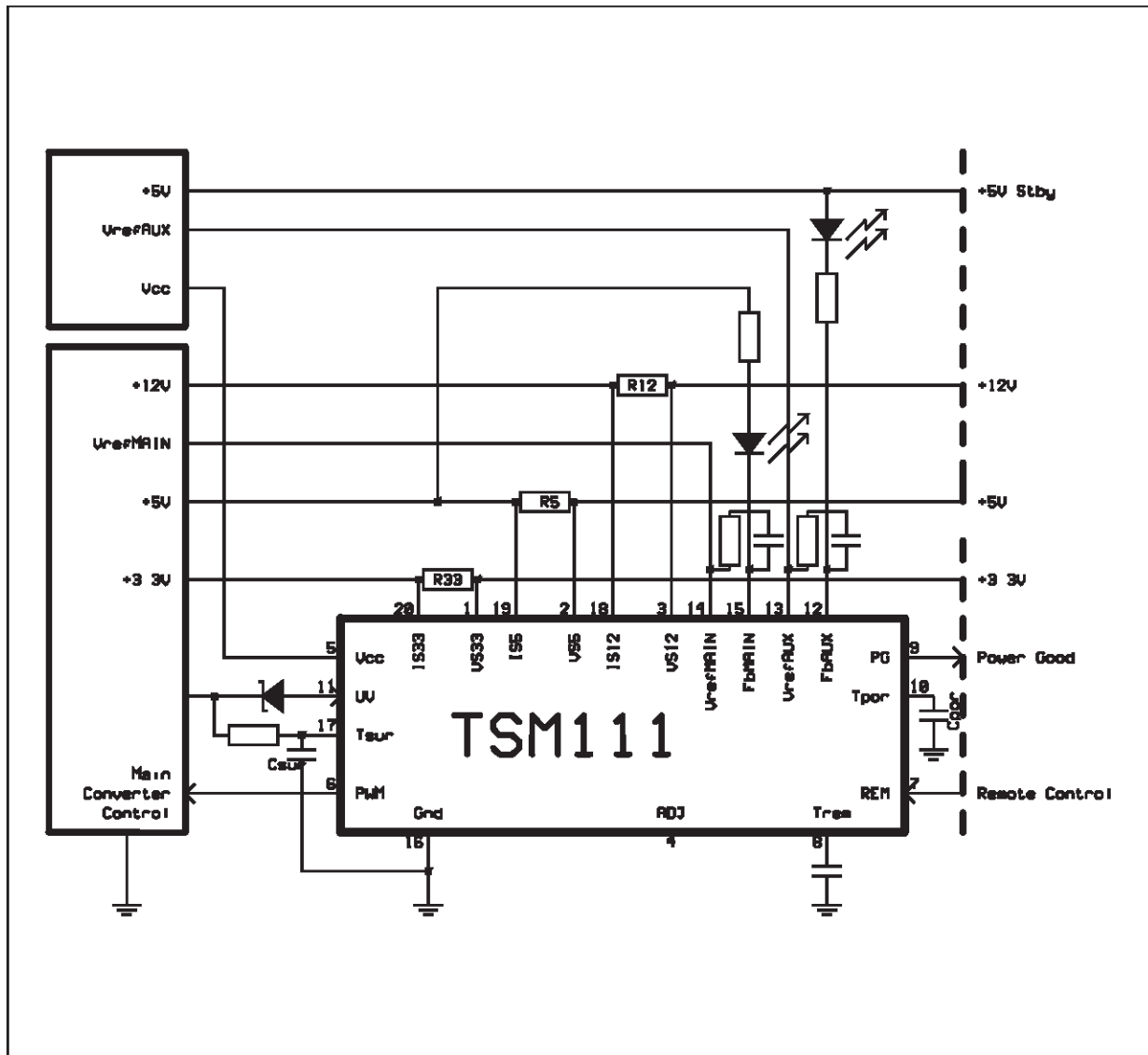
PIN DESCRIPTION

| Name | Pin | Type | Function |
|-----------------|-----|--------------------------|--|
| V _{CC} | 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 V _{CC} 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 μ C power supply = 2.7V). When not in use, this pin should be grounded. When in use, V _{S33} 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 μ C, 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 = 0.1 μ F |
| 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 = 2.2 μ F |
| 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. |

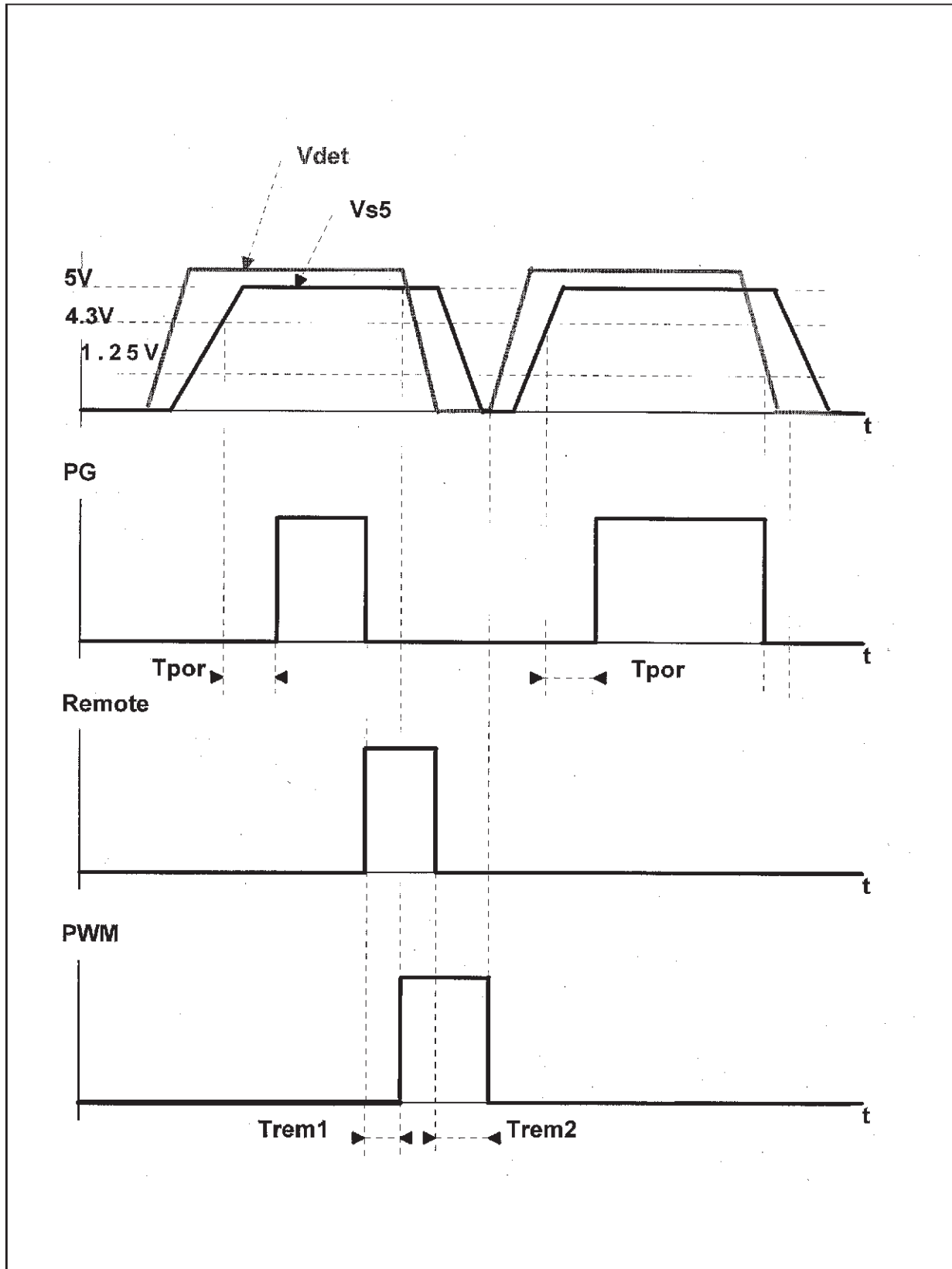


TSM111

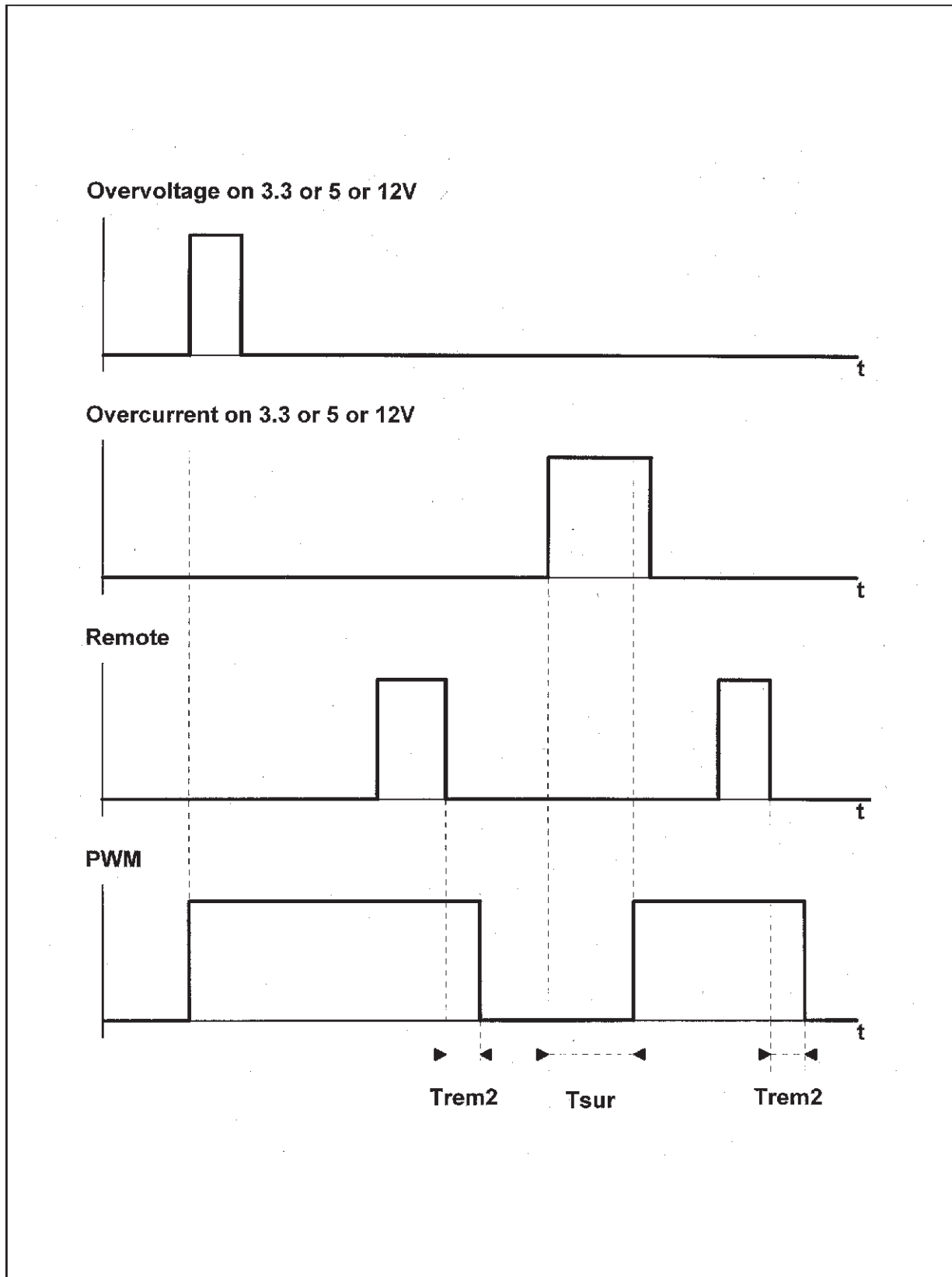
APPLICATION DIAGRAM



TIMING DIAGRAM : remote control



TIMING DIAGRAM : overvoltage or overcurrent shut-down



AN EXAMPLE OF 90W MICRO ATX POWER SUPPLY USING L5991A, VI-PER20 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 :

- Over voltage protection for 3.3V, 5V and 12V without external component.
 - Over current protection for 3.3V, 5V and 12V.
 - Generates Power Good signal.
 - Programmable timing for Power Good signal.
 - Wide range supply operating voltage up to 36V (44V AMR).
 - Stable internal voltage reference.
 - Two 1.6% voltage reference for Main and Auxiliary regulation.
 - Few external components.
 - Circuit occupies little space on PCB.
- 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.

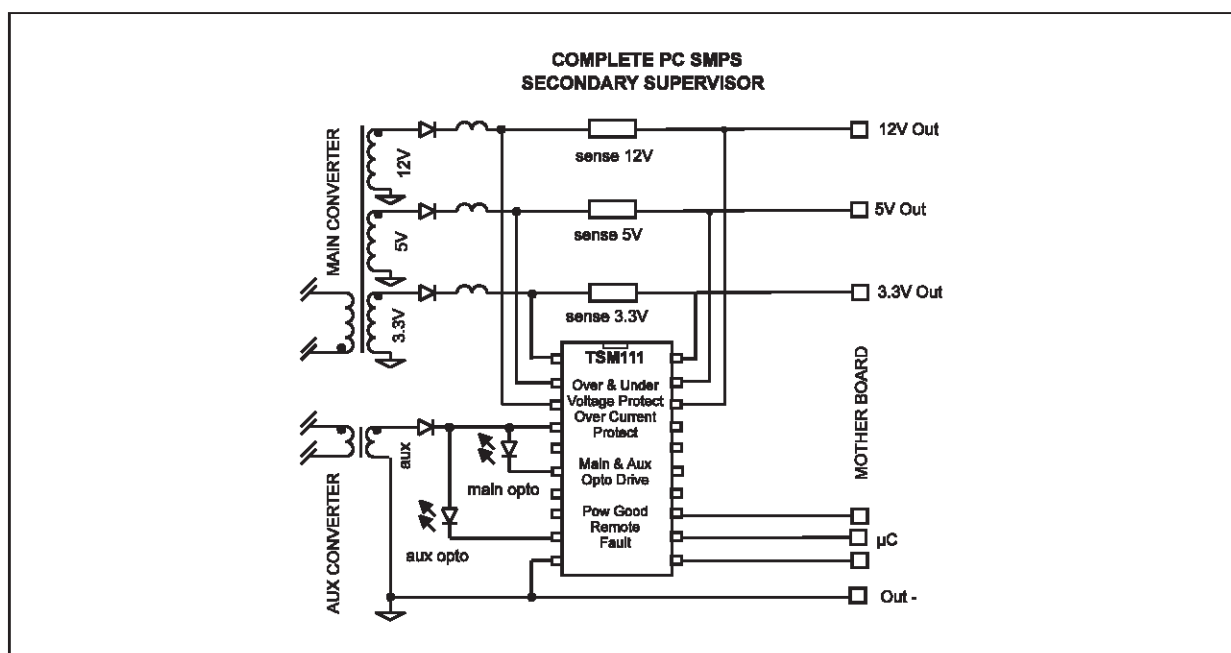
b) Over current protection can be implemented with very small value sense resistors. As the current sense threshold levels are set very low, regulation is not affected. The current sense threshold levels for 3.3V, 5V, 12V are 50mV, 50mV and 65mV respectively.

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 2.2 μ F/16V capacitor on pin 10, 400msec turn on delay is achieved.

e) The power supply can be operated from 14.5V to 36V. The V_{CC} 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 V_{CC} must be > 16V.

A COMPLETE PC SMPS SECONDARY SUPERVISOR



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

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 con-

dition. 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.

Note : 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/Descrptions |
|---------------------------------|----------------------------|----|---------------|---|
| ICs | | | | |
| 1 | L5991A | 1 | ST | Advanced PWM Controller |
| 2 | VIPer20DIP | 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 30V 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 | HM00-98150 | 1 | BI Tech.** | Aux Transformer |
| 13 | HM00-98151 | 1 | BI Tech. | Main Transformer |
| 14 | HM00-98148 | 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: 39-01-2200 | 1 | Molex | 20pin 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-230V selector | 1 | - | |



TSM111

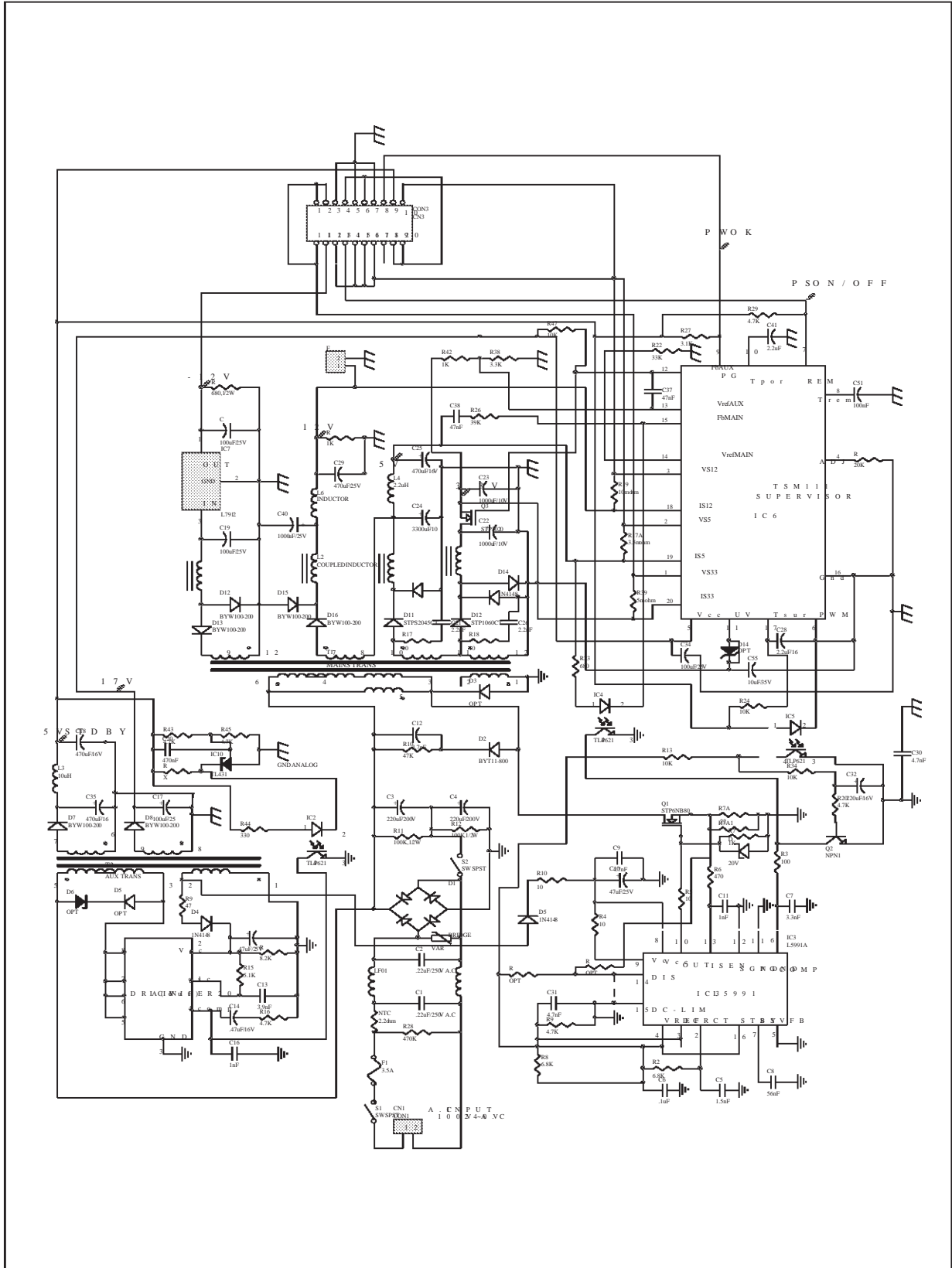
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| No | Part Number | Qt |
|----|-------------------|----|
| | Capacitors | |
| 27 | 47UF/25V | 1 |
| 28 | 3.9NF | 1 |
| 29 | .47UF/16V | 1 |
| 30 | 1NF | 2 |
| 31 | 100UF/25 | 1 |
| 32 | .22UF/250V A.C | 2 |
| 33 | 1000UF/10V | 2 |
| 34 | 3300UF/10 | 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 | 10R | 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 |

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TSM111

EVALUATION BOARD - TECHNICAL NOTICE

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 its 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 V_{vs1} , V_{vs2} , V_{vs3} 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 :

$$V_{cs1} = R1 \times I_{33} \quad \text{eq1}$$

$$V_{cs2} = R2 \times I_5 \quad \text{eq2}$$

$$V_{cs3} = R3 \times I_{12} \quad \text{eq3}$$

where I_{33} , I_5 , and I_{12} are the tripping currents.

The system will latch (Fault output will be active - high) if the overcurrent lasts more than the authorized surge delay T_{sur} given by equations 4 & 5 :

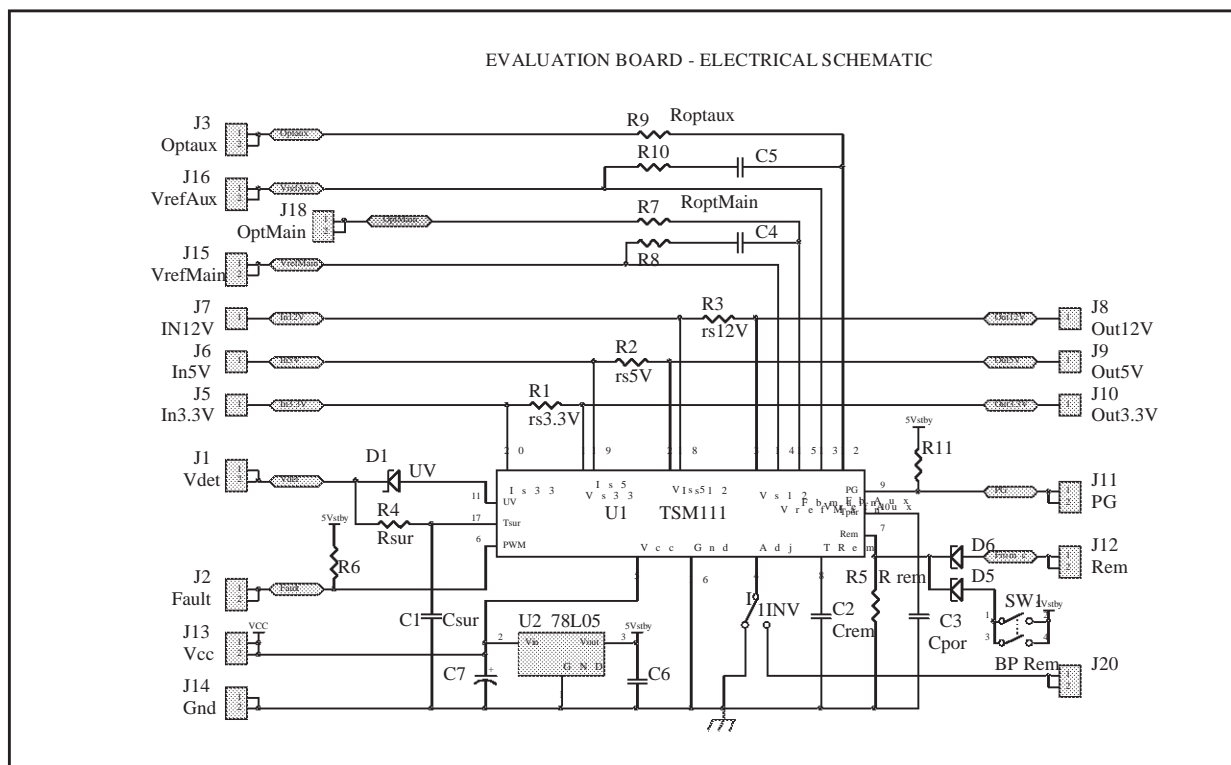
$$I_{charge} = V_{cc} / R4 \quad \text{eq4}$$

$$T_{sur} = (C1 \times V_{sur}) / I_{charge} \quad \text{eq5}$$

Note that eq4 is an approximation of a capacitive charge where V_{cc} (16V min) is large versus the threshold voltage V_{sur} (2.5V).

$$R4=33k\Omega, C1=4.7\mu F \Rightarrow T_{sur}=21ms$$

Thanks to the T_{sur} adjustment, the normal surge currents which occur during power up (capacitive



loads charging) are blanked for a time depending on each application.

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 :

$$C3 \times V_{th} = I_c \times T_{por} \quad \text{eq6}$$

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 | |

Figures 2a and 2b show the copper and silkscreen sides of the Evaluation board PCB.

Note that it is not a 1/1 scale.



TSM111

Figure 2a

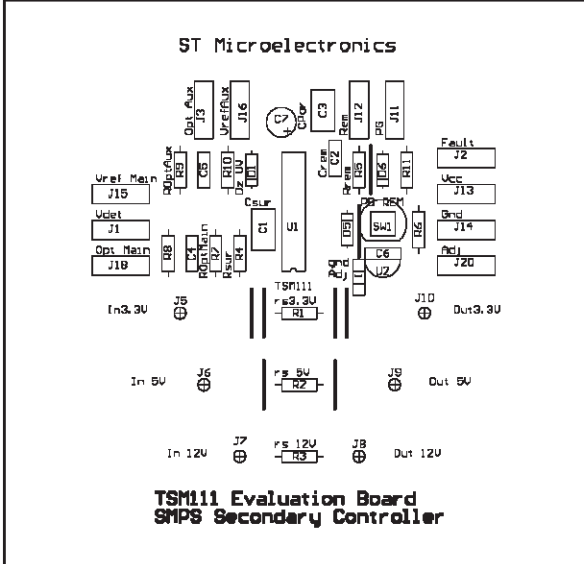
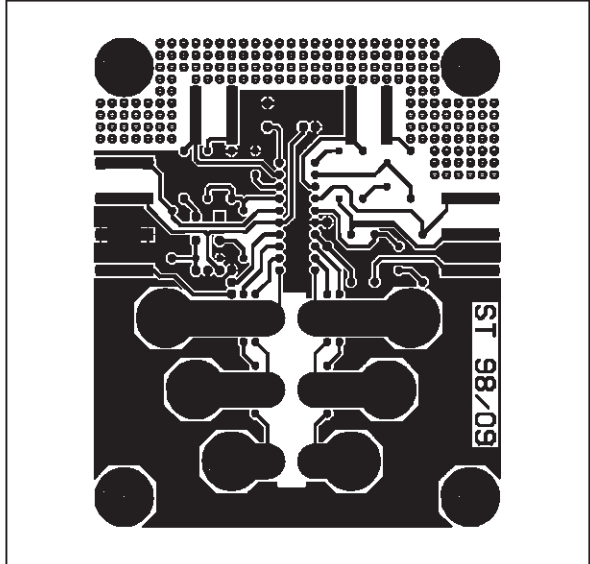
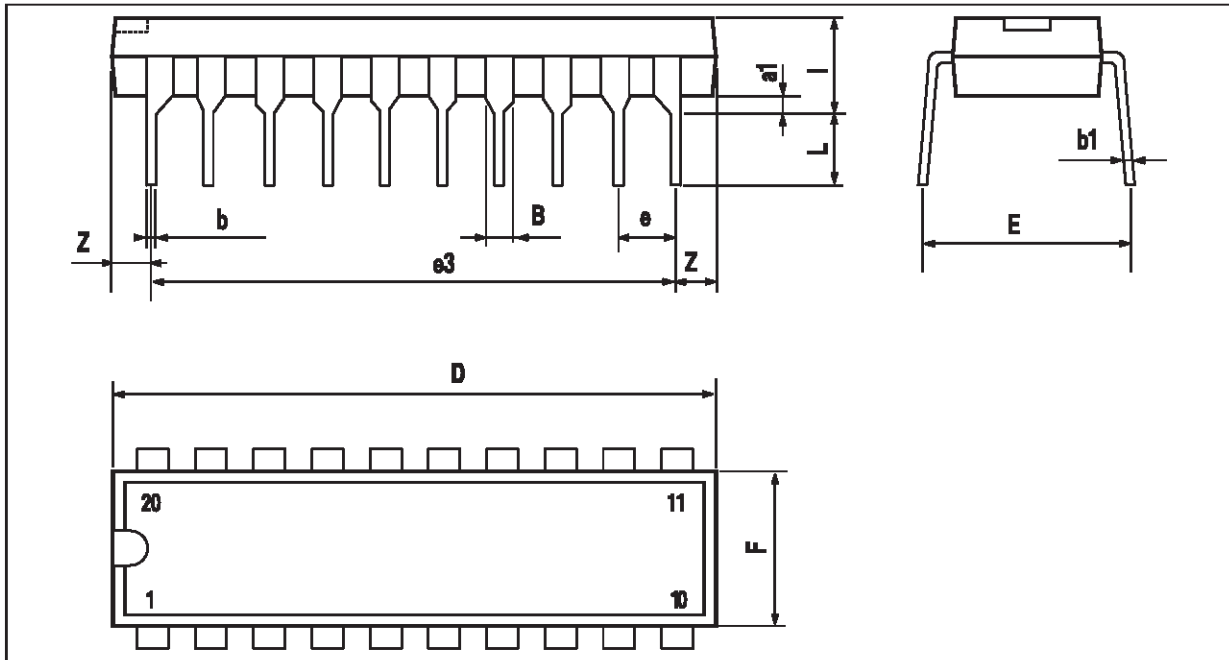


Figure 2b



PACKAGE MECHANICAL DATA

20 PINS -PLASTIC DIP

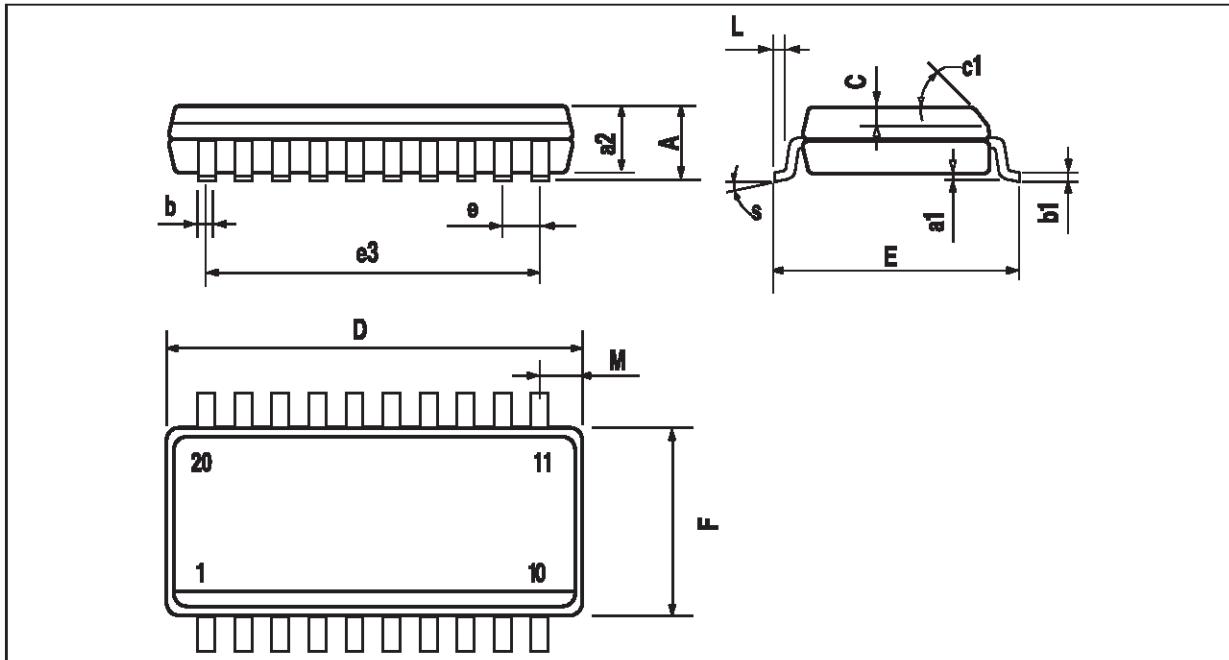


| Dimensions | Millimeters | | | Inches | | |
|------------|-------------|-------|------|--------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| a1 | 0.254 | | | 0.010 | | |
| B | 1.39 | | 1.65 | 0.055 | | 0.065 |
| b | | 0.45 | | | 0.018 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | |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



TSM111

PACKAGE MECHANICAL DATA 20 PINS -PLASTIC MICROPACKAGE (SO)



| Dimensions | 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.) | | | | | |

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