



Design specification of customer integrated circuit

TH2267.1

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TH2267.1 V2.2 26.05.2004

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1. Introduction

This document is based on the design specification „TH2267.1“.

The valid specification for the ASIC development is the existing german version V2.2 from 26.02.2004. Functional modifications may occur during the design process, but must be agreed and signed off by both Melexis and customer.

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1.1 Description

The TH2267 is an application specific device for the control of the primary side of a switched mode charger. The controlled variable is transferred by an additional winding from the secondary to the primary side. Additional references for the primary control function and the power supply are derived from the included bandgap reference. For control of the external bipolar transistor a push-pull driver stage is included. For the specific regulation characteristic resulting in driver switch-on and switch-off, current- and voltage monitoring with time constants and fixed characteristic curve are included. Overvoltage- and overcurrent-protection functions as well as voltage regulator and startup-circuit are included too. For the protection functions an additional z-diode reference contained.

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1.2 Functional diagram (ASIC in application circuit)

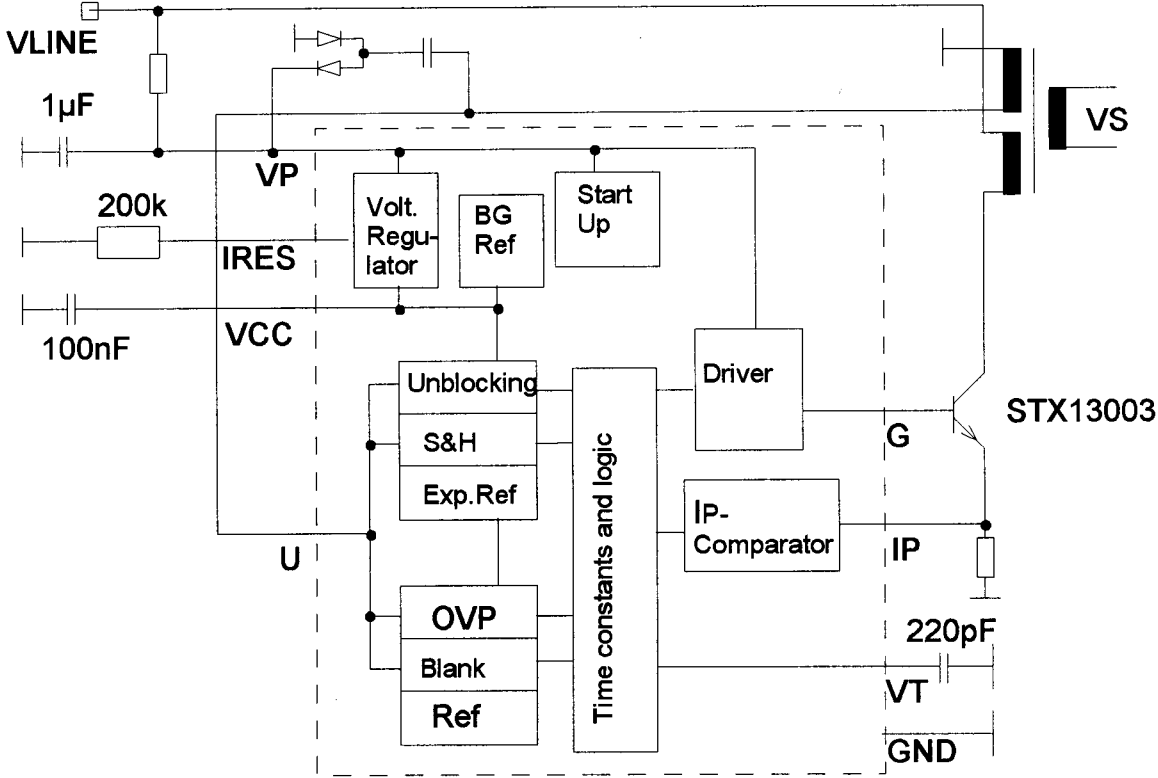


Figure 1: Functional diagram in principal application circuit

1.3 Hints on ESD/EMC

- The application circuit board should be designed to minimise electro-magnetic compatibility problems. ASIC can withstand disturbances smaller 40 V/m (< 2 GHz, <20 cm, Out < 0.5V). In this cases ASIC is in normal operating mode.
- The Chip is an ESD-sensitive device and should be handled according to guideline EN100015 part1 („The protection of ESD sensitive devices “).
- An ESD-robustness > 1000V according to MIL 883D is complied by the ASIC.

2. Electrical characteristics

All voltages are referenced to ground (GND = 0V).

Table 1 Absolute maximum ratings

| NR. | Parameter | Symbol | Min | Max | Unit |
|-----|----------------------|-----------|------|--------------|------|
| 1.0 | IC Supply voltage | V_P | -0.3 | 45 | V |
| | | V_{CC} | -0.3 | 5.5 | V |
| 1.1 | Input voltage, U | V_U | -45 | 50 | V |
| 1.2 | Input voltage, other | V_{IN} | -0.3 | $V_{CC}+0.3$ | V |
| 1.3 | Output voltage | V_{OUT} | -0.3 | $V_{CC}+0.3$ | V |
| 1.4 | Input current | I_{IN} | -10 | 10 | mA |
| 1.5 | Storage temperature | T_{STG} | -40 | 125 | °C |
| 1.6 | Power dissipation | PD SOIC8 | | 270 | mW |

Continuous operation of the device outside the defined "absolute ratings" is not allowed. It may cause permanent damage to the device. For the continuous operation of the device outside the defined "operating conditions" the correct function can not guaranteed. In this case the device reliability can be reduced.

Table 2 Operating conditions

| NR. | Parameter | Symbol | Min | Typ | Max | Unit |
|-----|----------------------|--------|--------------------|-----|------------------------|------|
| 2.0 | IC Supply voltage | V_P | 7.6 ^[1] | | 40 (44) ^[3] | V |
| | | | 9.5 ^[2] | | 40 (44) ^[3] | V |
| 2.1 | Ambient temperature | T_A | -20 | | 120 | °C |
| 2.2 | Junction temperature | T_J | | | <=150 | °C |

^[1] without voltage drop by driver switching

^[2] with 100nF on Pin VP and 10µs power-on time of the driver; application circuit should be guaranteed, that the voltage at VP in case of driver switch-on not decrease under the undervoltage lockout threshold

^[3] Continuous operation above 40V supply voltage violates the valid process specification of wafer supplier. This leads to degradation of reliability. This issue is more specified in chapter 8.

Table 3 Static characteristics supply voltage, V_{CC}
($V_p = 10V$, $T = -20$ to $100\text{ }^\circ\text{C}$)

| NR. | Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-----|--------------------------|-----------|---|------|-----|------|---------------|
| 3.0 | Supply Voltage | V_{CC} | $C=100\text{nF}$ | 4.5 | 5 | 5.5 | V |
| 3.1 | Supply Current (average) | I_{IS} | before startup, $T=25\text{ }^\circ\text{C}$ | | | 85 | μA |
| | | | before startup, $T=100\text{ }^\circ\text{C}$ | | | 130 | μA |
| | | | static | | | 440 | μA |
| | | | dynamic ^[1] , $f_{CLK} \leq 100\text{ kHz}$, without load | | | 500 | μA |
| 3.2 | Startup voltage | V_{STU} | | 15.0 | 20 | 22.5 | V |
| 3.3 | Undervoltage (lockout) | V_{LO} | | 6 | 6.7 | 7.5 | V |

Table 4 Static characteristics driver, pin G ($V_p = 10V$, $T = -20$ to $100\text{ }^\circ\text{C}$)
parameter 4.1 to 4.4 only measurable during reload time!

| NR. | Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-----|---|---------------|------------------------|-----|-----|-----|------------------|
| 4.0 | Pull-down resistor | R_{PD} | | 13 | 19 | 25 | $\text{k}\Omega$ |
| 4.1 | Output current source | $I_{SOURCEH}$ | $V_G = 2V$ | 18 | 25 | 40 | mA |
| 4.2 | Output current source after reload, $V_{IP} > V_{IP80\%}$ | $I_{SOURCEL}$ | $V_G = 2V$ | 0.3 | | 1.5 | mA |
| 4.3 | Output current sink | I_{SINK} | $V_G > 2V$ | 230 | | 610 | mA |
| 4.4 | Output voltage low | V_{GL} | $I_{SINK}=30\text{mA}$ | 0 | | 0.2 | V |
| 4.5 | Output voltage during startup and after lockout | V_{GSULO} | | | | 0.2 | V |

Table 5 Static characteristics driver, pin IP
($V_p = 10V$, $T = -20$ to $100\text{ }^\circ\text{C}$)

| NR. | Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-----|---------------------------------|--------------|-----------|-----|-----|-----|---------------|
| 5.0 | Input current IP ^[1] | I_{IP} | | | | 0.5 | μA |
| 5.1 | Threshold IP comparator | V_{IP} | | 435 | 485 | 535 | mV |
| 5.2 | Threshold 80% IP comp. | $V_{IP80\%}$ | | 345 | 395 | 455 | mV |

^[1] Parameter only measured and documented during characterisation period of the IC. This test is not provided in production.

Table 6 Static characteristics pin U ($V_p = 10V$, $T = -20$ to $100\text{ }^\circ\text{C}$)

| NR. | Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-----|---------------------------------|---------------|-----------|------|-----------|------|------------|
| 6.0 | Threshold enable comparator | V_{FREIG} | | 50 | 100 | 140 | mV |
| 6.1 | Threshold OVP comparator | V_{OVP} | | 7.3 | 8.0 | 9.0 | V |
| 6.2 | Threshold blank comparator | V_{AUSB} | | -1.2 | -1 | -0.8 | V |
| 6.3 | S&H reference | $V_{S\&HREF}$ | | 3.9 | 4.2 | 4.6 | V |
| 6.4 | S&H range ^[1] | $V_{S\&Hhub}$ | | | ± 0.1 | | V |
| 6.5 | Input resistance ^[1] | R_U | dynamic | 20 | 40 | 60 | k Ω |

Table 7 Dynamic characteristics ($V_p = 10V$, $T = -20$ to $100\text{ }^\circ\text{C}$, IRES = 200k)

| NR. | Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-----|--|----------------|---|-----|-----|-----|---------------|
| 7.0 | Lockout time ^[1] | T_{LO} | $V_G < 1V$ | | | 1 | μs |
| 7.1 | Minimal switch-on time | T_{LEB} | | 200 | 530 | 800 | ns |
| 7.2 | IP delay (after T_{LEB}) ^[1] | T_{IP} | $V_{IP} = V_{IP} + 50\text{mV}$, $V_G < 1V$, | | | 100 | ns |
| 7.3 | Minimal pause | $T_{PAUSEmin}$ | | 1.0 | | 2.8 | μs |
| 7.4 | Maximal pause | $T_{PAUSEmax}$ | $U > V_{S\&HREF} + 0.2V$ | 3.5 | 4.2 | 7.3 | ms |
| 7.5 | Blanking-time after OVP or fade-out | T_{OVP} | | 11 | 19 | 30 | ms |
| 7.6 | Enable delay for fade-out | T_{AUSB} | | 200 | 530 | 800 | ns |
| 7.7 | Short pulse suppression on AUSB ^[2] | T_{KAUSB} | | 60 | 180 | 280 | ns |
| 7.8 | Current flow ratio ^[3] | T_{IREG} | | 51 | | 60 | % |

^[1] Parameter only measured and documented during characterisation period of the IC. This test is not provided in production.

^[2] Parameter indirectly measured via $T_{AUSB} + T_{KAUSB}$.

3. Timing-Diagrams

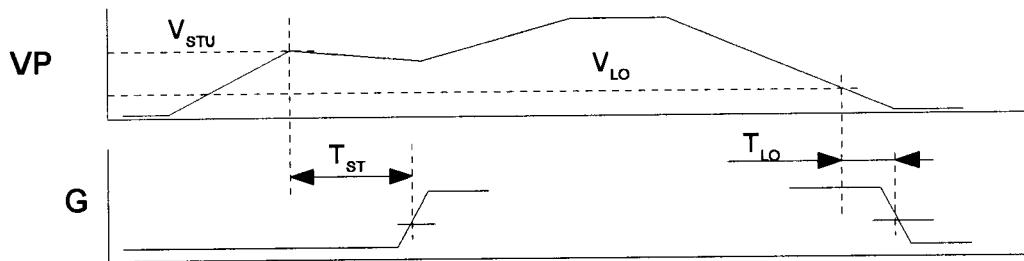


Figure 2: Startup and lockout time

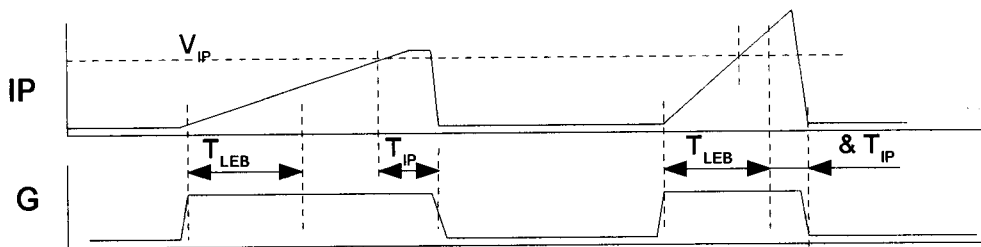


Figure 3: Switch-off through IP, after T_{LEB} and within T_{LEB}

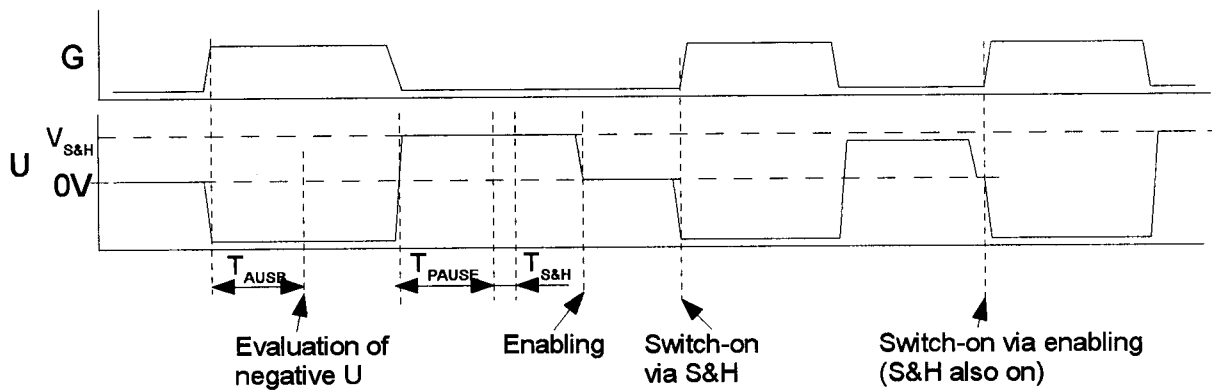


Figure 4: Normal function with switch-on per S&H or enabling

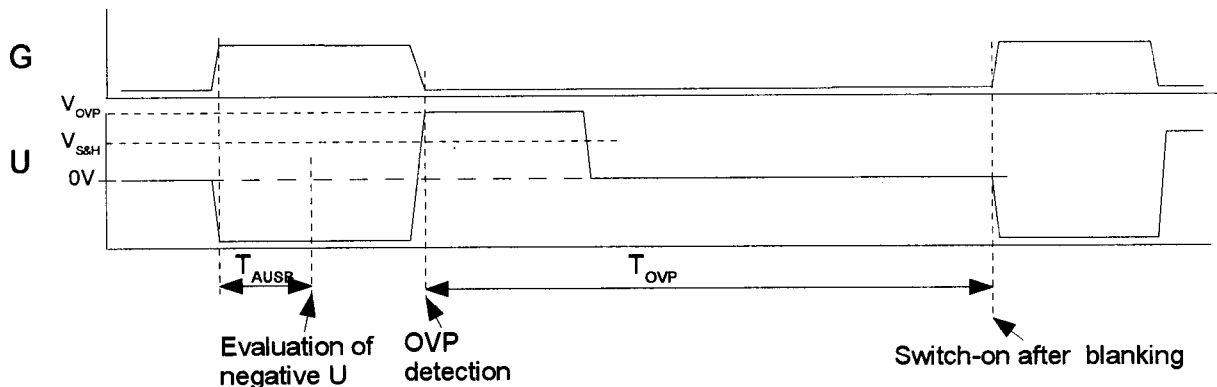


Figure 5: Activate of blanking time per OVP

4. *Functional description*

4.1 Functional flow

The TH2267 is a primary control unit for switch mode charger. The controlled variable is transferred by an auxiliary winding from the secondary to the primary side.

To activate the IC and switch-on the output driver, the IC supply voltage has to ramp up to the startup voltage. Exceeding the threshold voltage V_{IP} (represent the current of the primary coil via shunt measurement), the driver switch off. After 2/3 of the secondary current flow time (definite by enable), the voltage on the additional winding of the transformer stored by the sample and hold circuit. After compare of S&H-voltage with the exponential rising reference, the driver switch-on again and switch off at the threshold voltage V_{IP} . These toggle-behaviour persists as long as the IC supply voltage V_P drops under the lockout voltage. Then the ASIC is deactivated.

In order to prevent undesirable operating conditions additional protection circuits are included. The energy transfer of the transformer is monitored by the enable-comparator (the voltage at the auxiliary winding $< V_{FREIG}$). An earlier switch-on of the driver is impossible. In case of high voltages (peaks) at the auxiliary winding (over the control range), the OVP-comparator switch-off the output for a definite blanking time. The negative voltage at the auxiliary winding in case of activated driver is monitored by the blanking-comparator.

Before startup the power supply of the AISC results directly from the line voltage. In operating mode the power supply is delivered from the auxiliary winding.

4.2 Driver

The driver is a push pull stage with the supply voltage V_p . He provides the driving power for the external bipolar transistor. The output signal is current-limited to I_{SOURCE} . The output is connected to ground by a pull-down resistor, due to a definite startup- and lockout-output impedance. Apart from startup sequence the driver is low ohmic and forces the output voltage to a low level. The reload time for high is determined by the static threshold $V_{IP80\%}$.

4.3 Startup and internal power supply

The voltage regulator provides the internal power supply V_{CC} . For the supply voltages V_{CC} and V_p external capacitors are required. The current biasing of the IC is adjustable by an external resistor. Internal time constants, thresholds and the output current depends from the value of this resistor.

The startup circuit activate the IC after startup and deactivate the IC in case of undervoltage lockout.

4.4 S&H-circuit and exponential reference

The regulation function is realised by transfer of the secondary voltage to the auxiliary

winding during the phase of interlock. The secondary voltage is defined by the transmission ratio between the secondary and auxiliary winding. The voltage at the auxiliary winding is located in adjustment range by the control of switching pauses. The information is only present during the phase of interlock. Therefore a sample and hold circuit holds the voltage level for the phase of energy flow and pause. The suppression of overshoot voltages after toggling of the external FET is realised by a time constant T_{PAUSEmin} . The sampling takes place after T_{PAUSEmin} . The S&H-voltage represent the amplified control deviation. Using the exponential reference these value transferred to a time-dependent value. A negative control deviation (lower voltage) generates short switch-off phases, positive (higher voltage) long switch-off phases. The maximum pause is limited to T_{PAUSEmax} . The replication of the load ratio is empathised by the exponential distribution of the reference. The aperture time for the acquisition of the actual value to the hold-capacitor is dependent from the time of secondary current flow. These time of current flow is stored as an integrated voltage value. The stored value define the sampling time for the following pulse by a ratio of 2/3.

4.5 IP comparator

The current trough the external bipolar transistor is monitored by the IP comparator. Above the IP-threshold (V_{IP}) the output is switched off. If the $V_{\text{IP}80\%}$ -threshold voltage at pin IP is reached, the driver switch to a high ohmic state. This function is suppressed for the minimum switch-on time t_{LEB} after switch-on of external power transistor.

4.6 Safety functions

Three additional comparators connected to pin U to prevent from undesirable operating conditions.

If the voltage at the auxiliary winding is zero (energy in the transformer is zero), the enable-comparator approve a switch-on of the driver. The comparator detect the time of secondary current flow.

Positive voltages above the adjustment range are monitored by the OVP-comparator. To prevent from overvoltages he forces the driver to switch-off for the blanking time. For suppression of overshoot voltages the comparator input is shielded by a 6-stepped rc-filter.

Negative voltages during switch-on time of the external power transistor are monitored by the blanking-comparator. In case of absent negative voltages he also triggered the blanking time for the driver to prevent from a defect connection IC <-> auxiliary winding. To prevent from trigger fails delay and short pulse suppression are included for this function.

OVP- and blanking-comparator are separated from enable and S&H connected to pin U .

5. Pin location and description

| Pad | Pin SOIC8 | Name | IO-type | Function |
|-----|-----------|------|---------|--|
| 1 | 1 | IP | I | current sense |
| 2 | 2 | IRES | I/O | bias resistor |
| 3 | 3 | VP | P | IC supply voltage |
| 4 | 4 | G | O | driver output |
| 5 | 5 | GND | P | ground |
| 6 | 6 | U | I | input for auxiliary winding |
| 7 | 7 | VCC | P | supply voltage |
| 8 | 8 | VT | I/O | external capacitor for current control |

6. Package outlines

Engineering samples: CDIP8

Production: TH2267 SOIC8

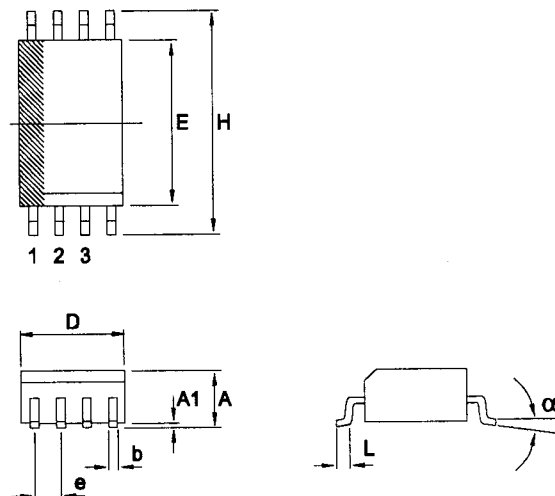


Figure 8: package SOIC8

6.1 Dimensions

| Dim. | | D | E | H | A | A1 | e | B | L | Copl | α |
|------|------|-------|-------|-------|-------|-------|-------|-------|-------|------|----------|
| mm | min | 4.80 | 3.80 | 5.80 | 1.35 | 0.10 | 1.27 | 0.33 | 0.40 | | 0° |
| | max. | 5.00 | 4.00 | 6.20 | 1.75 | 0.25 | | 0.51 | 1.27 | 0.10 | 8° |
| inch | min | 0.189 | 0.150 | 0.228 | 0.053 | 0.004 | 0.050 | 0.013 | 0.016 | | 0° |
| | max. | 0.197 | 0.157 | 0.244 | 0.069 | 0.010 | | 0.020 | 0.050 | 0.04 | 8° |

E

7. Soldering

This Melexis device TH2267, SOIC8NB, Assembly Subcontractor Carsem, is classified and qualified regarding JEDEC020 and moisture sensitivity level 1 (MSL1) for a lead free soldering technology with a maximum peak temperature of 250°C.

Following test methods are applied:

- IPC/JEDEC J-STD-020
Moisture/Reflow Sensitivity Classification For Nonhermetic Solid State Surface Mount Devices
- MIL 883 Method 2003 / EIA/JEDEC JESD22-B102
Solderability

D

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc.) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

C

Based on Melexis commitment to environmental responsibility, European legislation (Directive on the Restriction of the Use of Certain Hazardous substances, RoHS) and customer requests, Melexis has installed a Roadmap to qualify their package families for lead free processes also. Various lead free generic qualifications are running, current results on request.

For more information on Melexis lead free statement see quality page at our website: <http://www.melexis.com/html/pdf/MLXleadfree-statement.pdf>

8. Higher supply voltage

B

The operation of the IC at higher supply voltages $V_p > 40V$ up to 44V is equivalent to higher stress for the device. According to the valid process specification of the wafer supplier the maximum IC voltage is 40V. Minimisation of the higher risk was investigated by Melexis. Results of the analysis are committed by report to Friwo (14.10.2003).

However, based on the results of the report there is to ascertain that a risk of (process-) failures exist (breakdown voltage $< 50V$). Averaged there is a smallish risk, but it's possible that single lots are not usable regarding to the higher supply voltage requirements. Because of the valid process specification, Melexis cannot accept the costs for these lots.

Therefor the following procedure is valid:

- In addition to the existing PCM-selection parameter $UBPHV_{\geq 45V}$ an additional PCM-selection parameter $UBPHV_{\geq 50V}$ established (each wafer measured).
- Friwo received an information in case of non-compliance to the additional selection criteria $UBPHV_{\geq 50V}$.

A

TH2267.1 V2.2 26.05.2004

- Friwo has to pay for these produced wafers after accounting.
- Melexis scraps the accrued wafers.

9. Specification history

| Version | Date | Kind of change |
|---------|-----------|---|
| 1.1 | 25.10.02 | parameter 1.6, 2.0, 4.1, 4.3 changed, parameter 7.9 added |
| 1.2 | 2/17/2003 | parameter 3.1, 3.2, 4.1, 4.2, 4.3, 5.1, 5.2, 6.0, 6.1, 6.3, 6.4, 7.1, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8 regarding ppk-measurements from TH9384.2 modified, parameter 7.9 removed, parameter 6.0 adjusted |
| 1.3 | 4/02/2003 | tbd.-parameter fixed after ppk- measurements from TH9384.21 |
| 2.0 | 4/28/2003 | parameter 4.1, 4.2, 4.3, 5.1, 5.2, 6.0, 6.1, 6.3, 7.1, 7.3, 7.4,7.5, 7.6, 7.7 regarding cpk-measurements from TH2267.1 modified |
| 2.1 | 5/07/2003 | Figure 1.2: 200k-resistor instead of 240k; parameter 3.1, 4.1, 4.2, 7.7 regarding cpk-measurements from TH2267.1 with 200k-reference resistor modified |
| 2.2 | 2/26/2004 | parameter 2.0 higher supply voltage, parameter 5.0 changed, chapter 7 edited, chapter 8 added |