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# AS3691

## 4 Precision 400mA Current Sources for RGB and Single Color Leds

### 1 General Description

The AS3691 (AS3691A and AS3691B) features four high precision current sources for lighting of up to four LED strings (RGB or single color leds). Each of the four currents sources can be controlled independently by PWM inputs. The full scale current value is set by external resistors.

### 2 Key Features

- 4 x up to 0.4A constant current outputs
- Programmable with external resistors
- 4 independent PWM inputs
- Absolute current accuracy +/-0.5%
- Automatic Supply Regulation<sup>1)</sup> to reduce power dissipation<sup>1)</sup>

<sup>1)</sup> Patent Pending

- Very wide output voltage current source voltage compliance
  - Down to 0.41V
  - Up to 15V<sup>2)</sup>
- Integrated overtemperature protection
- Separate sense pads (Rfb1-Rfb4) for easy and precise PCB Layout
- Package
  - DIE
  - QFN24 4x4mm
  - eP-TSSOP

<sup>2)</sup> 15V is sufficient for most applications as the AS3691 does not switch off the LED current completely

### 3 Applications

- General Lighting
- Backlighting
- RGB Backlighting for LCD TV/Monitors with White Color Balancing

### 4 Application Diagrams

Figure 1 – Application Diagram of AS3691 for Single Color Lighting

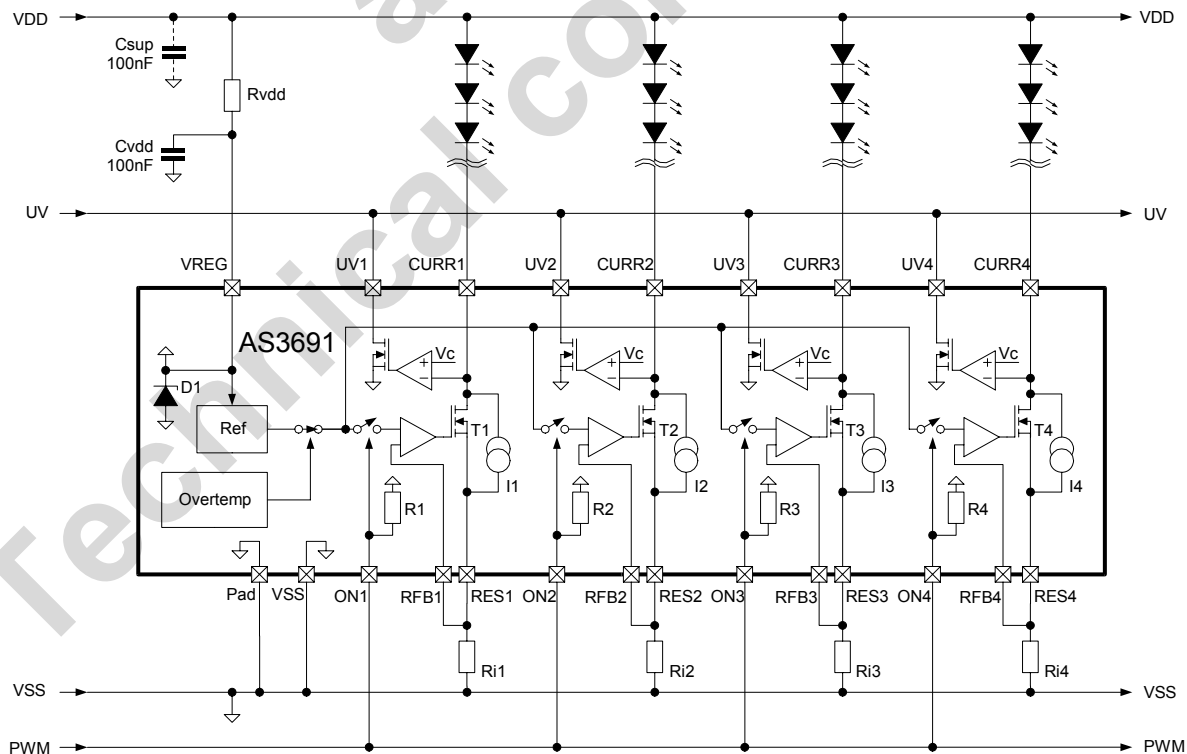
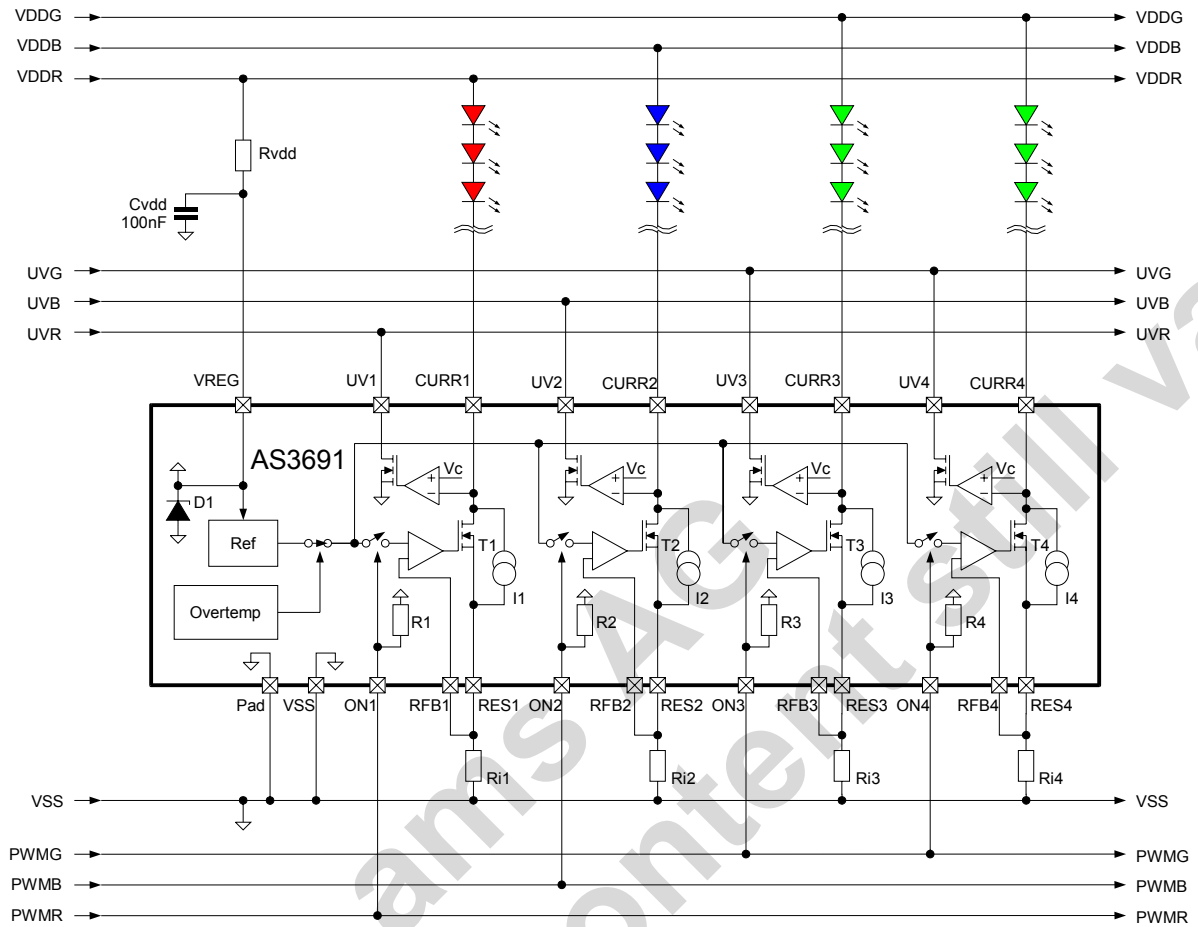


Figure 2 – Application Diagram of AS3691 for RGB Lighting



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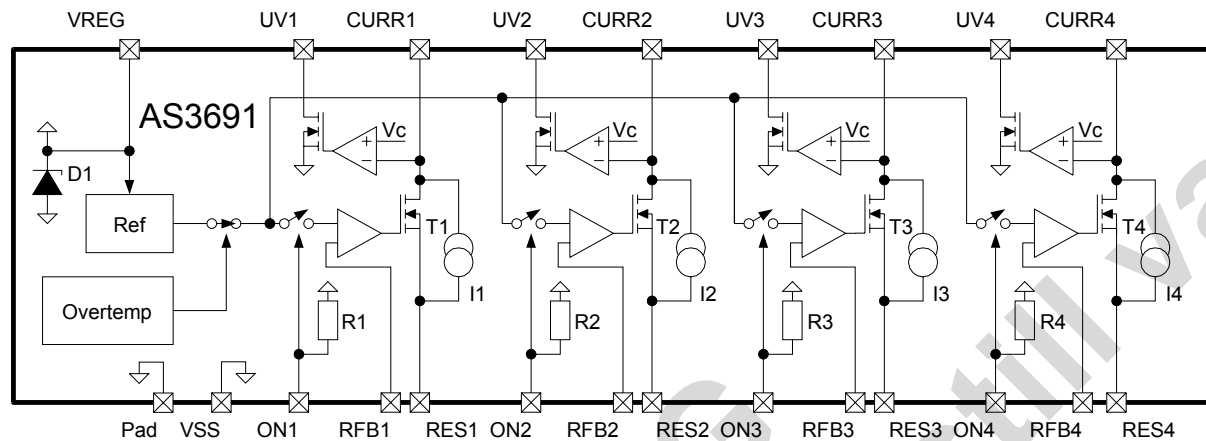
## Revision History

| Revision | Date       | Owner | Description                                                |
|----------|------------|-------|------------------------------------------------------------|
| 2.3      | 30.10.2007 | ptr   | - Added Trays as delivery option (order code AS3691A-ZQFT) |

## 5 Pinout

### 5.1 Pin Assignments

Figure 3 – Pin Usage



### 5.2 Pin Descriptions

Table 1 – Pin Type Descriptions

| Pin Type | Description       |
|----------|-------------------|
| AI/O     | Analog Pin        |
| AI       | Analog Input Pin  |
| AO       | Analog Output Pin |
| DI       | Digital Input     |
| S        | Supply Pin        |

Table 2 – Pin Descriptions

| Pin Number QFN Package | Pin Number ePTSSOP Package | Pin Name | Type | Description                                                    |
|------------------------|----------------------------|----------|------|----------------------------------------------------------------|
| 1                      | 10                         | CURRE1   | AI/O | Current Source 1 Output                                        |
| 2                      | 11                         | RFB1     | AI   | Connect to current set resistor R1 directly at resistor itself |
| 3                      | 12                         | nc       | nc   | Leave open                                                     |
| 4                      | 13                         | RFB4     | AI   | Connect to current set resistor R4 directly at resistor itself |
| 5                      | 14                         | CURRE4   | AI/O | Current Source 4 Output                                        |
| 6                      | 15                         | RES4     | AI/O | Connect to current set resistor R4                             |

## Datasheet

| Pin Number<br>QFN<br>Package | Pin Number<br>ePTSSOP<br>Package | Pin Name | Type | Description                                                                                                                                                      |
|------------------------------|----------------------------------|----------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7                            | 16                               | ON4      | DI   | Current source CURR4 control; internal pullup resistor to VREG (can be left open, if CURR4 is always switched on)<br>High ... 100% Current<br>Low ... 5% Current |
| 8                            | 17                               | UV4      | AO   | Automatic supply regulation for CURR4; if not used, leave open                                                                                                   |
| 9                            | 18                               | TEST     | AI   | Digital Test input; Leave open or connect to VSS; internal pulldown to VSS                                                                                       |
| 10                           | 19                               | UV3      | AO   | Automatic supply regulation for CURR3; if not used, leave open                                                                                                   |
| 11                           | 20                               | ON3      | DI   | Current source CURR3 control; internal pullup resistor to VREG (can be left open, if CURR3 is always switched on)<br>High ... 100% Current<br>Low ... 5% Current |
| 12                           | 21                               | RES3     | AI/O | Connect to current set resistor R3                                                                                                                               |
| 13                           | 22                               | CURR3    | AI/O | Current Source 3 Output                                                                                                                                          |
| 14                           | 23                               | RFB3     | AI   | Connect to current set resistor R3 directly at resistor itself                                                                                                   |
| 15                           | 24                               | VREG     | S    | Shunt regulator supply; connect to Rvdd and Cvdd                                                                                                                 |
| 16                           | 1                                | RFB2     | AI   | Connect to current set resistor R2 directly at resistor itself                                                                                                   |
| 17                           | 2                                | CURR2    | AI/O | Current Source 2 Output                                                                                                                                          |
| 18                           | 3                                | RES2     | AI/O | Connect to current set resistor R2                                                                                                                               |
| 19                           | 4                                | ON2      | DI   | Current source CURR2 control; internal pullup resistor to VREG (can be left open, if CURR2 is always switched on)<br>High ... 100% Current<br>Low ... 5% Current |
| 20                           | 5                                | UV2      | AO   | Automatic supply regulation for CURR2; if not used, leave open                                                                                                   |
| 21                           | 6                                | VSS      | S    | VSS Supply connection                                                                                                                                            |
| 22                           | 7                                | UV1      | AO   | Automatic supply regulation for CURR1; if not used, leave open                                                                                                   |
| 23                           | 8                                | ON1      | DI   | Current source CURR1 control; internal pullup resistor to VREG (can be left open, if CURR1 is always switched on)<br>High ... 100% Current<br>Low ... 5% Current |
| 24                           | 9                                | RES1     | AI/O | Connect to current set resistor R1                                                                                                                               |
| Pad                          | Pad                              | VSS      | S    | VSS Supply connection; add as many vias to ground plane as possible                                                                                              |

## 6 Characteristics

### 6.1 Absolute Maximum Ratings

Stresses beyond those listed in Table 1 may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in Section 5 Electrical Characteristics is not implied.

Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 3 – Absolute Maximum Ratings

| Symbol  | Parameter                         | Min   | Max           | Unit      | Note                                                               |
|---------|-----------------------------------|-------|---------------|-----------|--------------------------------------------------------------------|
| VDDMAX  | Supply for LEDs                   | -0.3  | >17           | V         | See notes <sup>1</sup>                                             |
| VINVREG | VREG Supply voltage               | -0.3  | 7.0           | V         | Applicable for pin VREG                                            |
| VIN5V   | 5V Pins                           | -0.3  | VREG+<br>0.3V | V         | Applicable for 5V pins <sup>2</sup>                                |
| VIN15V  | 15V Pins                          | -0.3  | 17            | V         | Applicable for CURR1, CURR2, CURR3 and CURR4                       |
| IIN     | Input Pin Current                 | -25   | +25           | mA        | At 25°C, Norm: Jedec 17                                            |
| TSTRG   | Storage Temperature Range         | -55   | 125           | °C        |                                                                    |
|         | Humidity                          | 5     | 85            | %         | Non condensing                                                     |
| VESD    | Electrostatic Discharge           | -2000 | 2000          | V         | Norm: MIL 883 E Method 3015                                        |
| PT      | Total Power Dissipation           |       | 2.0           | W         | At 50°C, no airflow for QFN24 on two layer FR4-Cu PCB <sup>3</sup> |
| PDERATE | PT Derating Factor                |       | 23            | mW/<br>°C | See notes <sup>3</sup>                                             |
| TBODY   | Body Temperature during Soldering |       | 260           | °C        | according to IPC/JEDEC J-STD-020C                                  |

Notes:

- As the AS3691 is not directly connected to this supply. Only the parameters VINVREG, VIN5V and VIN15V have to be guaranteed by the application
- All pins except CURR1, CURR2, CURR3 and CURR4
- Depending on actual PCB layout and especially number of vias below the exposed pad – see layout recommendations; can be improved e.g. with AI-PCB or airflow

### 6.2 Operating Conditions

Table 4 – Operating Conditions

| Symbol  | Parameter                          | Min | Typ  | Max         | Unit | Note                                                                           |
|---------|------------------------------------|-----|------|-------------|------|--------------------------------------------------------------------------------|
| VDD     | Main Supply                        |     |      | Not Limited | V    | Supply is not directly connected to the AS3691 – see section ‘Shunt Regulator’ |
| VDDTOL  | Main Supply Voltage Tolerance      | -20 |      | +20         | %    | Applies only for supply VREG is connected via Rvdd                             |
| VREGINT | Supply (shunt regulated by AS3691) | 5.0 | 5.2  | 5.4         | V    | If internally (shunt-)regulated by D1                                          |
| VREGEXT |                                    | 4.5 | 4.75 | 5.0         | V    | If externally supplied                                                         |
| IVREG   | Supply Current                     |     |      | 2.5         | mA   | Excluding current through shunt regulator (D1) – see section ‘Shunt Regulator’ |
| TAMB    | Ambient Temperature                | -20 | 25   | 85          | °C   |                                                                                |

## 6.3 Electrical Characteristics

Table 5 – Analog Electrical Characteristics

| Symbol                 | Parameter                                        | Min  | Typ | Max                | Unit | Note                                                                                                                                                |
|------------------------|--------------------------------------------------|------|-----|--------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| V <sub>CURR</sub>      | Current Source CURR1 to CURR4 Voltage Compliance | 0.9  |     | 15.0               | V    | at 400mA; total power dissipation limit PT must not be exceeded                                                                                     |
|                        |                                                  | 0.41 |     | 15.0               | V    | at 100mA                                                                                                                                            |
| I <sub>CURR</sub>      | Current Source Range                             | 10   |     | 400 <sup>(1)</sup> | mA   | ONx = high<br>I <sub>CURRx</sub> = 250mV / R <sub>ix</sub> (x=1...4)                                                                                |
| I <sub>CURR, TOL</sub> | Current Source Tolerance                         | -0.5 |     | +0.5               | %    | @25°C T <sub>JUNCTION</sub> , excluding variation of external resistors; V(CURRx) ≤ 4.0V                                                            |
|                        |                                                  | -1.5 |     | +1.5               | %    | -20°C to +100°C <sup>(2)</sup> T <sub>JUNCTION</sub> , -20°C to +85°C T <sub>AMB</sub> , excluding variation of external resistors; V(CURRx) ≤ 4.0V |
| V <sub>C</sub>         | Automatic Supply Regulation compare voltage      |      | 1.0 |                    | V    | See section 'Automatic Supply Regulation'                                                                                                           |
| V <sub>C, GAIN</sub>   | Automatic Supply Regulation gain                 |      | 2.0 |                    | mA/V | Voltage to current ratio; output current range typ 0 to 200uA                                                                                       |
| I <sub>1-4</sub>       | Parallel Current                                 |      |     | 1.0                | mA   | V(CURRx) ≤ 15V                                                                                                                                      |
|                        |                                                  |      |     | 0.1                | mA   | V(CURRx) ≤ 5.0V                                                                                                                                     |
| TOVTEMP                | Overtemperature Limit                            |      | 140 |                    | °C   | Maximum junction temperature                                                                                                                        |

**Notes:**

1. To obtain higher currents connect more than one current source in parallel
2. Accuracy at +100°C guaranteed by design and verified by laboratory characterization

Table 6 – Digital Input pins characteristics for pins ON1, ON2, ON3 and ON4

| Symbol          | Parameter                | Min | Typ | Max              | Unit | Note                                                                                                                                                  |
|-----------------|--------------------------|-----|-----|------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| V <sub>IH</sub> | High Level Input voltage | 2.3 |     | V <sub>REG</sub> | V    |                                                                                                                                                       |
| V <sub>IL</sub> | Low Level Input voltage  | 0.0 |     | 0.9              | V    |                                                                                                                                                       |
| R <sub>PU</sub> | Pullup resistor          |     | 70  |                  | kΩ   | Internal pullup resistor R1 to R4 to V <sub>REG</sub>                                                                                                 |
| f <sub>ON</sub> | Input Frequency Range    | 0   |     | 20               | kHz  | This defines the actual input frequency seen on the input ON1 to ON4; the basic frequency to generate the PWM signal is not limited by this parameter |



## 7 Typical Operation Characteristics

Figure 4 – Output Current versus Voltage on Current Source – High Current Range

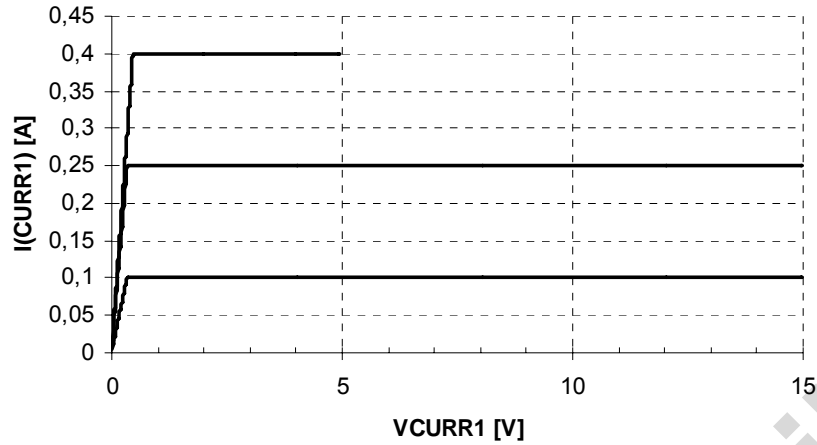


Figure 5 – Output Current versus Voltage on Current Source – Low Current Range

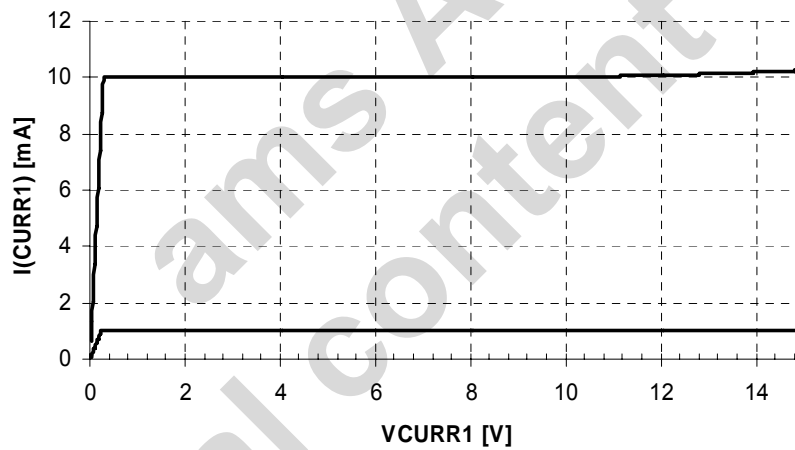
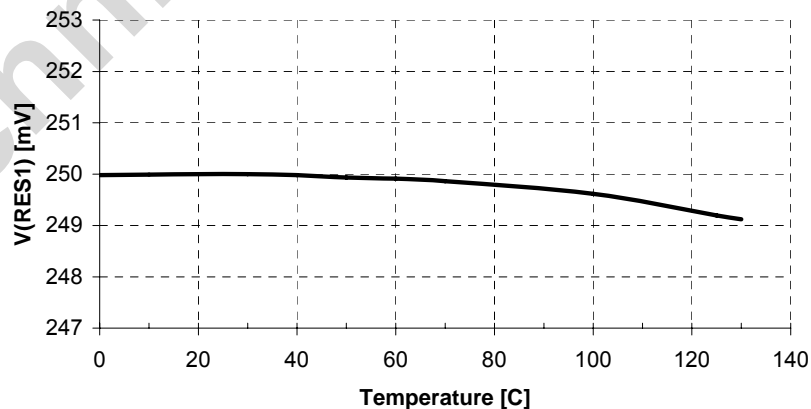


Figure 6 – Internal voltage reference versus Temperature,  $V(\text{CURR1}) = 2.0\text{V}$ ,  $R_{i1} = 250\Omega$



$$I_{\text{CURR1}} = \frac{V(\text{RES1})}{R_{i1}}$$

Figure 7 – Output Current versus Temperature,  $V(\text{CURR1}) = 2.0\text{V}$ ,  $R_{i1} = 2.5\Omega$  (Note: temperature coefficient of  $R_{i1} = -200\text{ppm}/^\circ\text{C}$ )

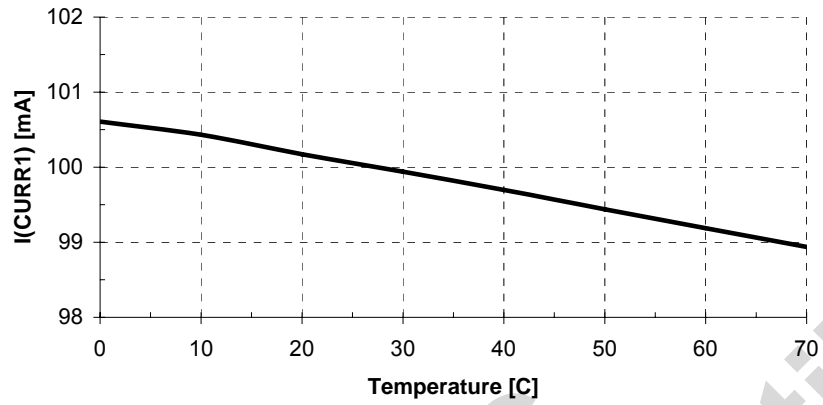


Figure 8 – Cross coupling of pwm on CURR1 to CURR2;  $I(\text{CURR1}) = 100\text{mA}$  to  $4\text{mA}$ ,  $I(\text{CURR2}) = 100\text{mA}$ ; AS3691A

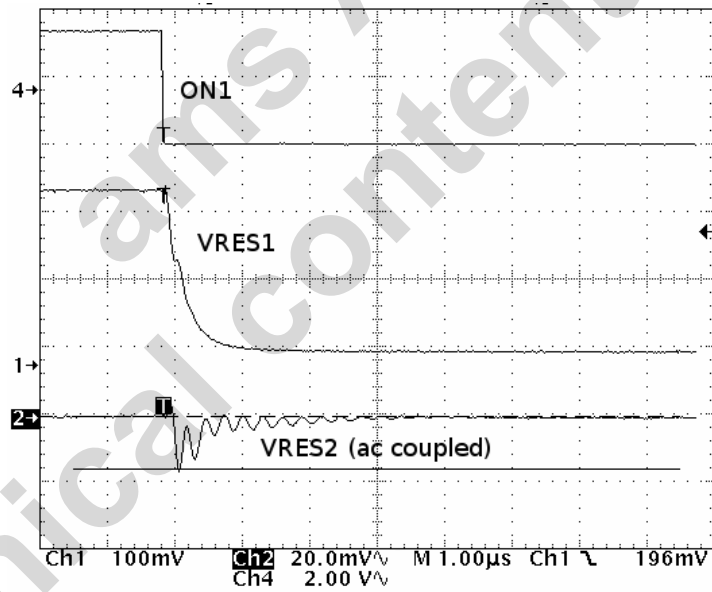


Figure 9 – PWM performance of Current Source CURRE1, I(CURRE1) changed between 400mA (ON1=1) and 20mA (ON1=0); AS3691A

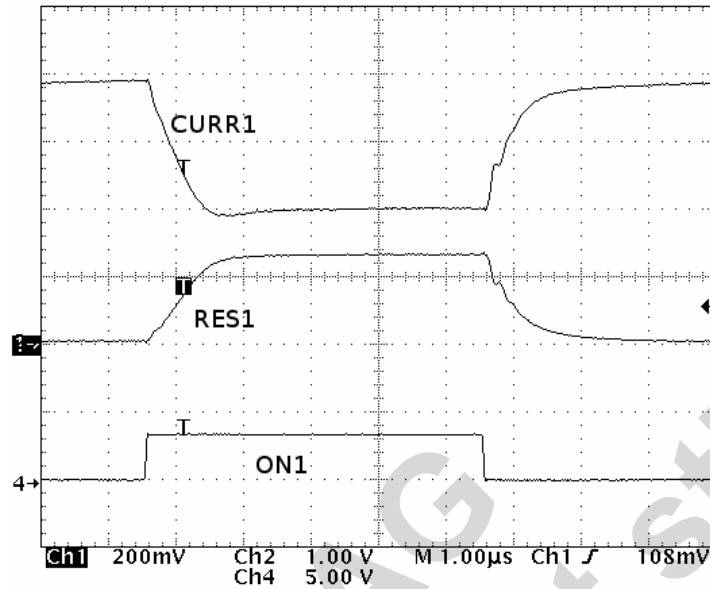


Figure 10 – Shunt Regulator Voltage VREG versus supply VDD with Rfb=1kΩ

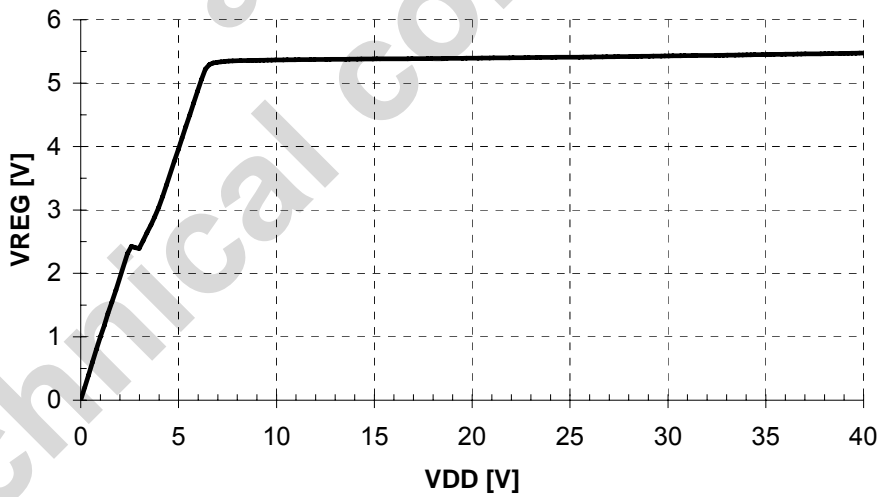


Figure 11 – Automatic Supply Regulation dynamic performance using DCDC converter in regulation loop (as in section 7.3)  
 $R1 = 47k\Omega$ ,  $R2 = 10k\Omega$ ,  $R3 = 5k\Omega$ ,  $R4 = 500\Omega$ ,  $C1 = 1\mu F$ ,  $I(CURR1) = 400mA/20mA$  ( $Ri1=0.625\Omega$ )  
 3 OSRAM Golden Dragon in series as load between CURR1 and VDD  
 Input signal on pin ON1: PWM signal with  $f=10kHz$ , 80% duty cycle

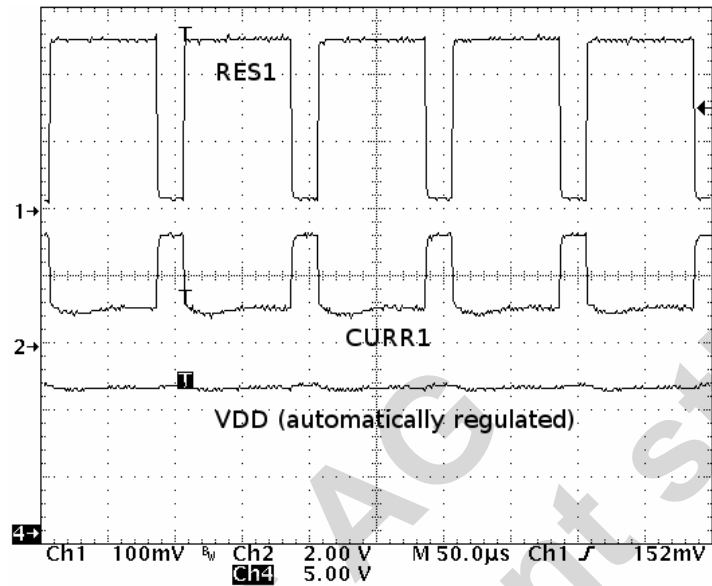
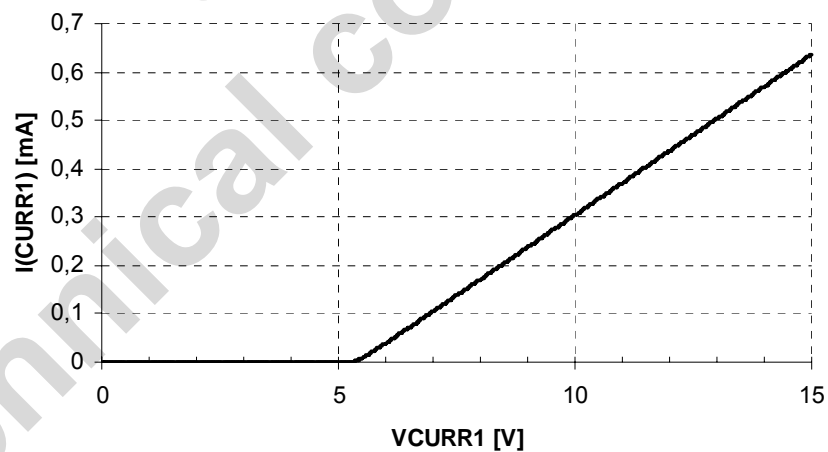


Figure 12 – Parallel Current I1 to I4 (for measurement of I1 remove current set resistor R1)



## 8 Detailed Functional Description

The AS3691 includes four high precision current sources (sinks). Each current source is set by an external resistor. For internal power supply an internal shunt regulator is used. Optionally an additional 5V device can be supplied as well with this shunt regulator.

The current sources are individually controlled by four ON inputs. If the inputs ON are high or left open, then the current is set as follows:

$$ICURR_{1-4} = \frac{250mV}{Ri_{1-4}}$$

Setting the input ON to low the current is

$$ICURR_{1-4} = \frac{10.0mV}{Ri_{1-4}} \quad \text{for part numbers starting with AS3691A}$$

The current is not zero to avoid high voltage jumps on the LEDs and supplies and therefore reduce EMI.

$$ICURR_{1-4} = \frac{0.0mV}{Ri_{1-4}} + I_{1-4} = I_{1-4} \quad \text{for part numbers starting with AS3691B; } I_{1-4} \text{ is the parallel current (see above Figure 11)}$$

### 8.1 Shunt Regulator

The supply of the AS3691 is generated from the high voltage supply. To obtain a 5V regulated supply, a series resistor Rvdd is used together with an internal zener diode (shunt regulator principle). An external capacitor Cvdd is used to filter the supply on the pin VREG.

The external resistor Rvdd has to be chosen according to the following formula:

$$Rvdd = \frac{VDD_{MIN} - VVREGINT_{MAX}}{IVREG_{MAX}} \quad VDD_{MIN} \text{ is the minimum voltage of the supply, where Rvdd is connected}$$

This ensures enough supply current (IVREGMAX) for the AS3691 under minimum supply voltage VDDMIN.

If a stable 5V supply within the operating conditions limits of VREGEXT is already existing in the system it is possible to supply the AS3691 directly. In this case remove the resistor Rvdd and connected this supply directly to VREG.

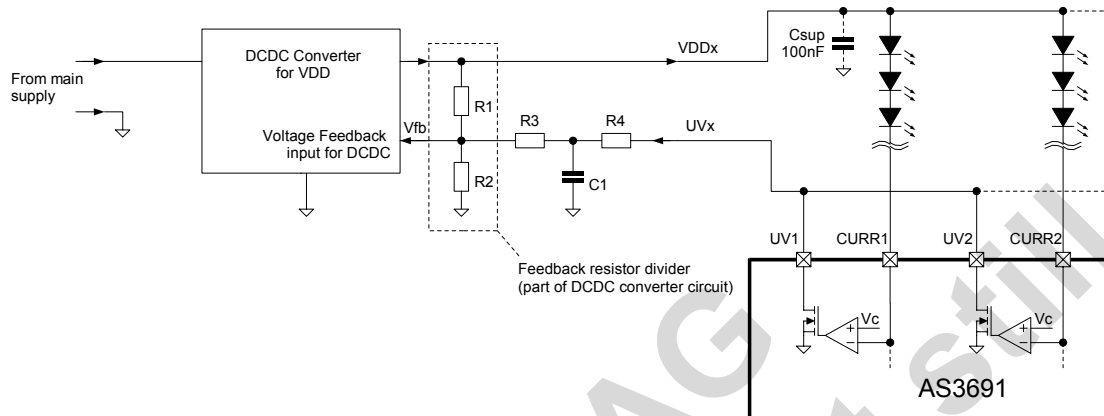
### 8.2 Overtemperature Protection

If the junction temperature inside the AS3691 rises above TOVTEMP, the current sources are switched off.

## 8.3 Automatic Supply Regulation

The purpose of the automatic supply regulation is to minimize the voltage supply to reduce the voltage across the current sources of the AS3691 (CURR1-CURR4 to VSS) and therefore reduce the power dissipation of the AS3691 and the complete system. The AS3691 automatically controls the minimum required supply voltage for the different led strings to support very power efficient systems for lighting using the following circuit (any off-the-shelf dc/dc converter or ldo with adjustable output voltage can be used):

Figure 13 – Automatic Supply Regulation Circuit



The function of this circuit is as follows:

All channels, which are connected to the supply VDDx should have their respective UV pin connected together to UVx (see above Figure and Section 'Application Schematic'). If any of these current sources has a too low voltage, it gradually pulls the wire UVx low. (The analog gain between the current source CURRx and output UVx is defined by the parameter  $V_{C,GAIN}$ .)

Therefore the feedback pin Vfb of the dc/dc converter is pulled low and the dc/dc converter compensates this by increasing the voltage on VDDx to obtain the same feedback voltage as before.

To stabilize this regulation loop, the low pass filter build by C1 and R4 is used (this should be the dominant pole for the regulation loop).

The minimum output voltage  $VDDx_{min}$  can be set accurately by the resistors R1 and R2. The maximum output voltage  $VDDx_{max}$  is set by R1, R2, R3 and R4 ( $V_{ref}$  is the internal voltage reference of the DCDC converter; usually  $V_{ref} = V_{fb}$ ):

$$VDDx_{MIN} = V_{ref} \frac{R_1 + R_2}{R_2}$$

$$VDDx_{MAX} = V_{ref} \frac{R_1 + R_2 \parallel (R_3 + R_4)}{R_2 \parallel (R_3 + R_4)}$$

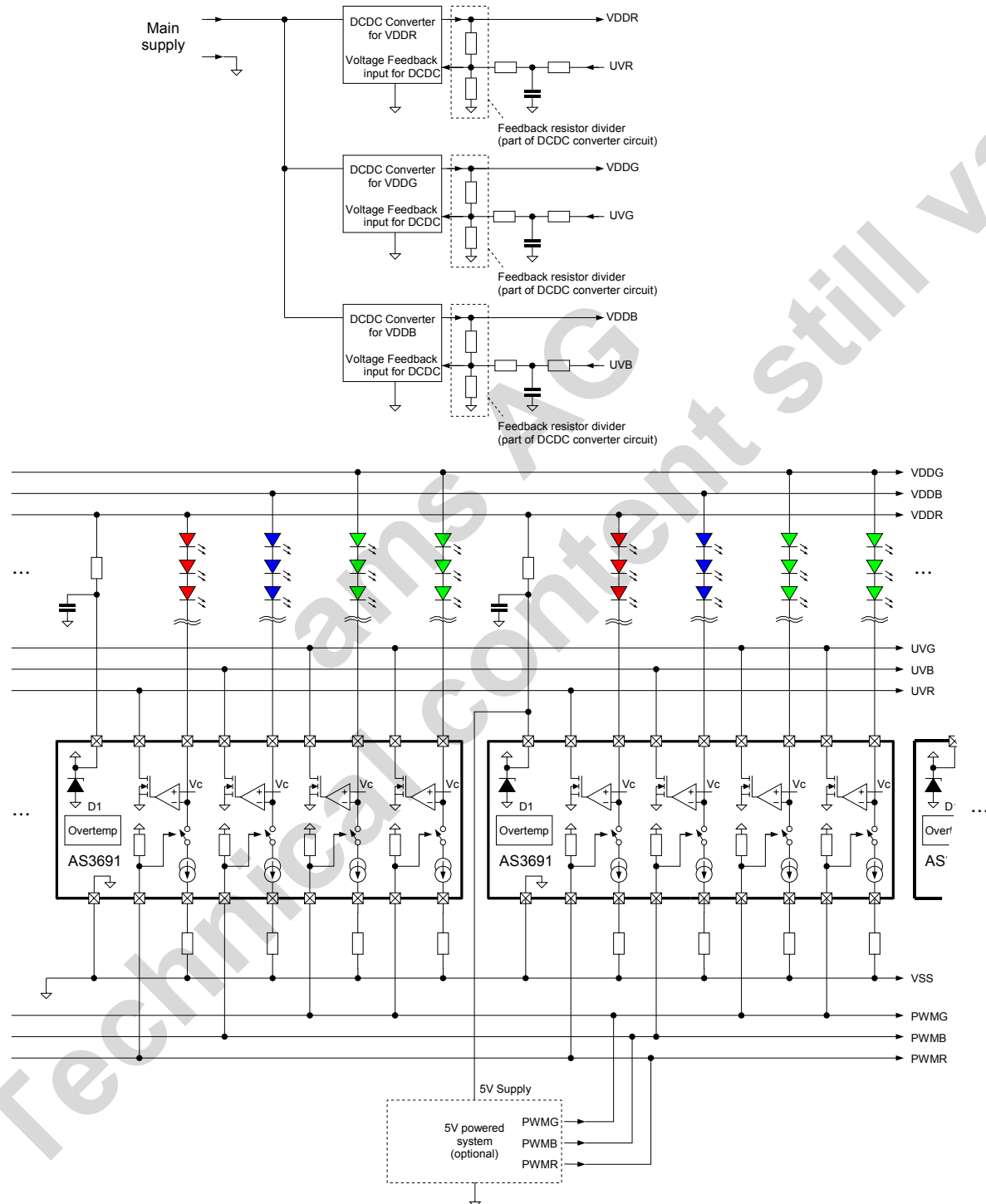
Therefore even if a led string is broken (then UVx is forced to 0V) or some leds are shorted, the supply always stays within the limits  $VDDx_{MIN}$  and  $VDDx_{MAX}$ .

## 9 Application Information

### Typical Application Schematic

For RGB leds (and a white color balancing circuit) use the following application schematic including automatic supply regulation (feedback paths UVR, UVG, UVB):

Figure 14 – Typical AS3691 System for RGB (back-)lighting; several AS3691 can be cascaded







Then calculate the maximum power dissipation inside the AS3691. The worst case is maximum voltage supply (13V + 10%) together with LEDs with minimum forward voltage  $U_{fmin}$  :  
For these conditions the maximum voltage on any current source (CURR1 to CURR4) is

$$VCURR_{MAX} = (1 + VDD_{TOL}) VDD - n U_{fmin} \quad \text{Not using automatic supply regulation}$$

In our example  $14.3V - 9.6V = 4.7V$ . The maximum power dissipation inside the AS3691 is now (assuming 4 identical strings)

$$P_{MAX} = 4 VCURR_{MAX} ICURR$$

In our example 1.88W. As

$$T_{MAX} = \frac{PT - P_{MAX}}{P_{DERATE}} + 50^{\circ}C \quad \text{For PT and PDERATE see Absolute Maximum Ratings}$$

the system can be operated safely up to an ambient temperature of 55°C assuming worst case power supplies and worst case leds. Please note: If the internal junction temperature of the AS3691 rises too high, the AS3691 will switch off the current sources for protection (it will never damage the AS3691).

### 9.1.1 Using Automatic Supply Regulation

For the identical system using the automatic supply regulation, the supply is regulated to minimize the power dissipation of the system. Therefore the tolerance of the VDD supply and also the variation in forward voltages of the LEDs can be ignored (only the difference in one lot of leds is still important, as the four strings are connected in parallel to the power supply). Assume a difference of  $\Delta U_f = 0.2V$  of forward voltage of the leds in one lot, then calculate the maximum voltage on the current source of the AS3691 (CURR1 to CURR4) with

$$VCURR_{MAX} = n \Delta U_f + V_C \quad \begin{array}{l} \text{Using automatic supply regulation} \\ \Delta U_f \text{ variation of LED forward voltage} \\ \text{in one lot (for one application)} \\ V_C \text{ is internal set voltage (1.0V)} \end{array}$$

to be 1.6V. Using the identical formulas as above, P<sub>MAX</sub> now is 0.64W and T<sub>MAX</sub> is 110°C.

Therefore using automatic supply regulation, the ambient temperature can be up to 110°C under identical conditions.

## 9.2 Layout Recommendations

See austriamicrosystems 'AN3691\_Tech\_Module Description' as a layout example for the AS3691.

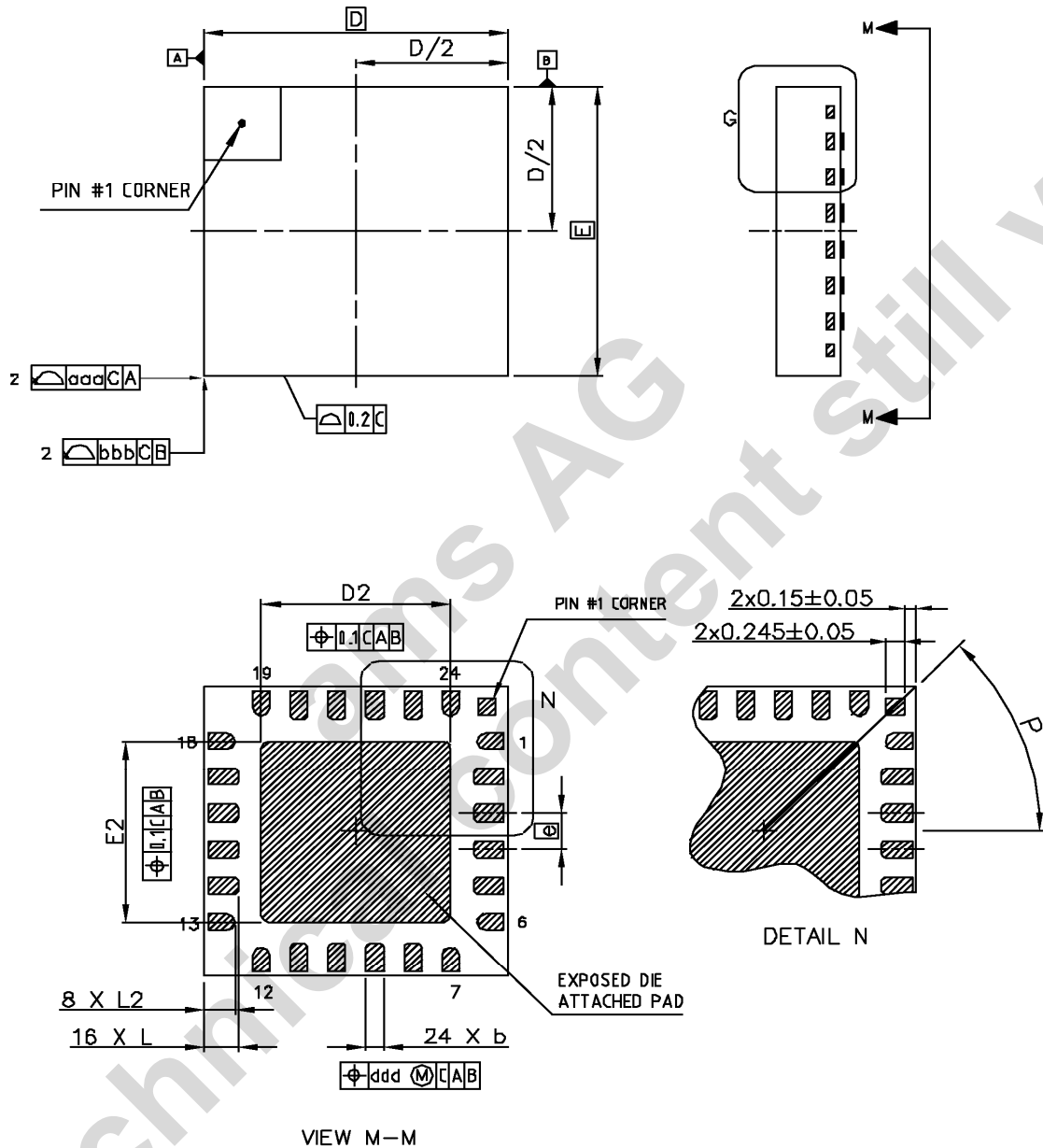
### Layout Checklist

1. Use the bottom layer as ground plane and minimize the number and the length of connections within this layer
2. Do as many vias as possible on the exposed pad (for thermal performance) to the ground plane
3. Connect RFBx and RESx together at the current set resistor Rix (see above recommended layout)
4. The ground connections of the current set resistors should be as close to the AS3691 as possible
5. The ground connection of the capacitor Cvdd should be as close as possible to the AS3691
6. Minimize Area build by 'Csup VSS connection – Csup Supply Connection – LEDs – CURRx – Csup VSS connection' (to minimize inductance in this path)

## 10 Package Drawings and Markings

### 10.1 QFN 4x4 Package Drawings and Marking

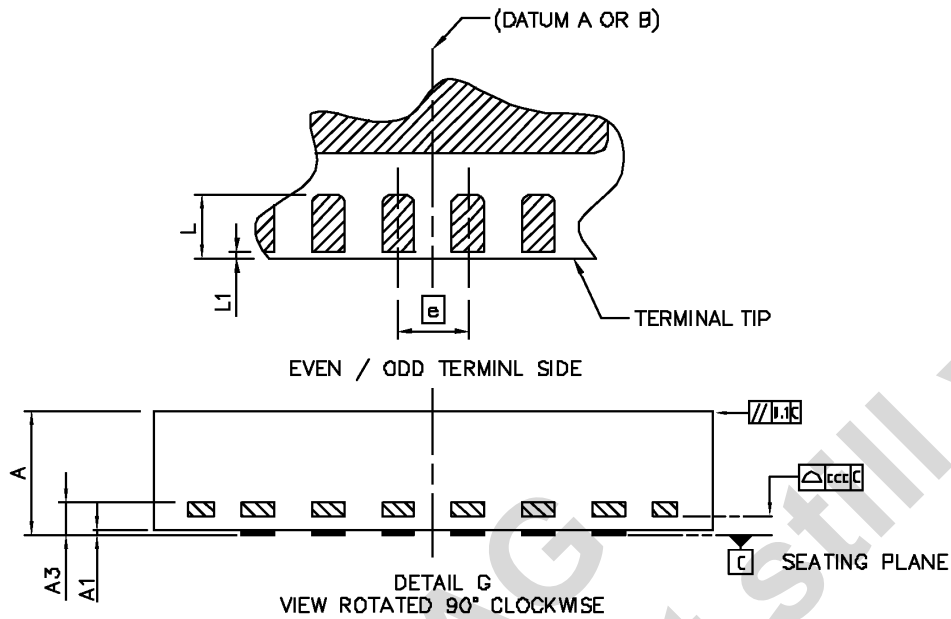
Figure 16 – QFN 24 – 4x4mm



#### Marking:

Line 1: austriamicrosystems Logo  
 Line 2: AYWWIZZ  
 A = Pb-Free Identifier  
 Y = Year  
 WW = Week  
 I = Plant Identifier  
 ZZ = Letters of Free Choice  
 Line 3: AS3691, AS3691A or AS3691B

Figure 17 – QFN 24 – 4x4mm Detail Dimensions



| DIM | MIN        | NOM  | MAX  | NOTES                                                                                                                                                                                               |                         |                    |
|-----|------------|------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------|
| A   | 0.80       | 0.85 | 0.90 | 1.0 DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994.<br>2.0 ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.                                                                       |                         |                    |
| A1  | 0.00       | 0.02 | 0.05 |                                                                                                                                                                                                     |                         |                    |
| A3  | 0.203 REF. |      |      |                                                                                                                                                                                                     |                         |                    |
| b   | 0.18       | 0.23 | 0.30 |                                                                                                                                                                                                     |                         |                    |
| D   | 4.0 BSC    |      |      |                                                                                                                                                                                                     |                         |                    |
| E   | 4.0 BSC    |      |      | 3.0 DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25mm AND 0.30mm FROM TERMINAL TIP. DIMENSION L1 REPRESENTS TERMINAL FULL BACK FROM PACKAGE EDGE UP TO 0.1mm IS ACCEPTABLE. |                         |                    |
| e   | 0.50 BSC   |      |      |                                                                                                                                                                                                     |                         |                    |
| D2  | 2.40       | 2.50 | 2.60 | 4.0 COPLANARITY APPLIES TO THE EXPOSED HEAT SLUG AS WELL AS THE TERMINAL.                                                                                                                           |                         |                    |
| E2  | 2.40       | 2.50 | 2.60 |                                                                                                                                                                                                     |                         |                    |
| L   | 0.40       | 0.45 | 0.50 | 5.0 RADIUS ON TERMINAL IS OPTIONAL.                                                                                                                                                                 |                         |                    |
| L1  | 0.03       | 0.05 | 0.08 |                                                                                                                                                                                                     |                         |                    |
| L2  | 0.35       | 0.40 | 0.45 |                                                                                                                                                                                                     |                         |                    |
| P   | 45° REF    |      |      |                                                                                                                                                                                                     |                         |                    |
| aaa | 0.10       |      |      |                                                                                                                                                                                                     |                         |                    |
| bbb | 0.10       |      |      |                                                                                                                                                                                                     |                         |                    |
| ccc | 0.08       |      |      |                                                                                                                                                                                                     |                         |                    |
| ddd | 0.10       |      |      |                                                                                                                                                                                                     |                         |                    |
|     |            |      |      | UNIT                                                                                                                                                                                                | DIMENSION AND TOLERANCE | REFERENCE DOCUMENT |
|     |            |      |      | Millimeter(mm)                                                                                                                                                                                      | ASME Y14.5M             | JEDEC MO-220       |



## Datasheet

## Marking:

Line 1: austriamicrosystems Logo  
 Line 2: AYWWIZZ  
     A = Pb-Free Identifier  
     Y = Year  
     WW = Week  
     I = Plant Identifier  
     ZZ = Letters of Free Choice  
 Line 3: AS3691, AS3691A or AS3691B

Figure 19 – ePTSSOP Package Drawing Detail Dimensions

| SYMBOL         | COMMON DIMENSIONS |       |      | NOTE       | D    |      |      | P    | P1  | 7  |
|----------------|-------------------|-------|------|------------|------|------|------|------|-----|----|
|                | MIN.              | NOM.  | MAX. |            | MIN. | NOM. | MAX. |      |     |    |
| A              | —                 | —     | 1.10 | AA/AAT     | 2.90 | 3.00 | 3.10 | 1.59 | 3.2 | 8  |
| A <sub>1</sub> | 0.05              | —     | 0.15 | AB-1/ABT-1 | 4.90 | 5.00 | 5.10 | 3.1  | 3.0 | 14 |
| A <sub>2</sub> | 0.85              | 0.90  | 0.95 | AB/ABT     | 4.90 | 5.00 | 5.10 | 3.0  | 3.0 | 16 |
| aaa            | 0.076             |       |      | AC/ACT     | 6.40 | 6.50 | 6.60 | 4.2  | 3.0 | 20 |
| b              | 0.19              | —     | 0.30 | 9 AD/ADT   | 7.70 | 7.80 | 7.90 | 5.5  | 3.2 | 24 |
| b <sub>1</sub> | 0.19              | 0.22  | 0.25 | AE/AET     | 9.60 | 9.70 | 9.80 | 5.5  | 3.0 | 28 |
| bbb            | 0.10              |       |      |            |      |      |      |      |     |    |
| c              | 0.09              | —     | 0.20 |            |      |      |      |      |     |    |
| c <sub>1</sub> | 0.09              | 0.127 | 0.16 |            |      |      |      |      |     |    |
| D              | SEE VARIATIONS    |       |      | 5          |      |      |      |      |     |    |
| E <sub>1</sub> | 4.30              | 4.40  | 4.50 | 5          |      |      |      |      |     |    |
| e              | 0.65 BSC          |       |      |            |      |      |      |      |     |    |
| E              | 6.40 BSC          |       |      |            |      |      |      |      |     |    |
| L              | 0.50              | 0.60  | 0.70 | 6          |      |      |      |      |     |    |
| N              | SEE VARIATIONS    |       |      | 7          |      |      |      |      |     |    |
| P              | SEE VARIATIONS    |       |      | 13         |      |      |      |      |     |    |
| P <sub>1</sub> | SEE VARIATIONS    |       |      | 13         |      |      |      |      |     |    |
| α              | 0°                | —     | 8°   |            |      |      |      |      |     |    |

## NOTES:

- DIE THICKNESS ALLOWABLE IS 0.279±0.0127 (0.110±0.005 INCHES)
- DIMENSIONING & TOLERANCES PER ASME, Y14.5M-1994.
- DATUM PLANE H LOCATED AT MOLD PARTING LINE AND COINCIDENT WITH LEAD, WHERE LEAD EXITS PLASTIC BODY AT BOTTOM OF PARTING LINE.
- DATUM A-B AND D TO BE DETERMINED WHERE CENTERLINE BETWEEN LEADS EXITS PLASTIC BODY AT DATUM PLANE H.
- \*D\* & \*E<sub>1</sub>\* ARE REFERENCE DATUM AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS, AND ARE MEASURED AT THE BOTTOM PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15mm ON D AND 0.25mm ON E PER SIDE.
- DIMENSION IS THE LENGTH OF TERMINAL FOR SOLDERING TO A SUBSTRATE.
- TERMINAL POSITIONS ARE SHOWN FOR REFERENCE ONLY.
- FORMED LEADS SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITHIN 0.076mm AT SEATING PLANE.
- THE LEAD WIDTH DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.07mm TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND AN ADJACENT LEAD SHOULD BE 0.07mm FOR 0.65MM PITCH, 0.08mm FOR 0.50MM PITCH AND 0.07mm FOR 0.40MM PITCH PACKAGES. SEE SECTION \*B-B\*.
- SECTION \*B-B\* TO BE DETERMINED AT 0.10 TO 0.25 MM FROM THE LEAD TIP.
- CONTROLLING DIMENSION: MILLIMETERS.
- THIS PART IS COMPLIANT WITH JEDEC SPECIFICATION MO-153 VARIATIONS AA/AAT, AB-1/ABT-1, AB/ABT, AC/ACT, AD/ADT, AE/AET, BC-1/BCT-1, BD-1/BDT-1, BE/BET, CA/CAT & CD/CDT AND MO-194 VARIATIONS AC/ACT & AF/AFT.
- DIMENSIONS \*P\* AND \*P<sub>1</sub>\* ARE THERMALLY ENHANCED VARIATIONS. VALUES SHOWN ARE MAXIMUM SIZE OF EXPOSED PAD WITHIN LEAD COUNT AND BODY SIZE. END USER SHOULD VERIFY AVAILABLE SIZE OF EXPOSED PAD FOR SPECIFIC DEVICE APPLICATION.

ALL DIMENSIONS IN MILLIMETERS

## 10.3 DIE Delivery

Please contact austriamicrosystems for die delivery.

## 11 Ordering Information

Table 7 – Ordering Information

| Part Number                | Marking                                               | Package Type     | Delivery Form                | Description                                                                                                    |
|----------------------------|-------------------------------------------------------|------------------|------------------------------|----------------------------------------------------------------------------------------------------------------|
| AS3691A-ZQFP               | AS3691A <sup>1)</sup><br>-or-<br>AS3691 <sup>1)</sup> | QFN 24<br>4x4mm  | Tape and Reel<br>in Dry Pack | Package Size = 4x4x0.85mm,<br>Pitch = 0.5mm, Pb-Free;<br>10mV on VRES for ON=0                                 |
| AS3691A-ZQFT               | AS3691A                                               | QFN 24<br>4x4mm  | Trays<br>in Dry Pack         | Package Size = 4x4x0.85mm,<br>Pitch = 0.5mm, Pb-Free;<br>10mV on VRES for ON=0                                 |
| AS3691A-ZSDF <sup>2)</sup> | (AS3691A)                                             | Sorted<br>Wafers | Cut Dies on Foil             | Sorted Wafers;<br>10mV on VRES for ON=0                                                                        |
| AS3691B-ZQFP               | AS3691B                                               | QFN 24<br>4x4mm  | Tape and Reel<br>in Dry Pack | Package Size = 4x4x0.85mm,<br>Pitch = 0.5mm, Pb-Free;<br>0mV on VRES for ON=0                                  |
| AS3691B-ZSDF <sup>2)</sup> | (AS3691B)                                             | Sorted<br>Wafers | Cut Dies on Foil             | Sorted Wafers;<br>0mV on VRES for ON=0                                                                         |
| AS3691A-ZTSP <sup>2)</sup> | AS3691A                                               | ePTSSOP          | Tape and Reel<br>in Dry Pack | Enhanced Power TSSOP (with power pad),<br>Body Size=4.4mm<br>Pitch = 0.65mm, Pb-Free;<br>10mV on VRES for ON=0 |
| AS3691B-ZTSP               | AS3691B                                               | ePTSSOP          | Tape and Reel<br>in Dry Pack | Enhanced Power TSSOP (with power pad),<br>Body Size=4.4mm<br>Pitch = 0.65mm, Pb-Free;<br>0mV on VRES for ON=0  |

**Note:**

- 1) AS3691 with 10mV on VRES for ON=0 can be marked with 'AS3691' or 'AS3691A' (identical behavior)
- 2) Contact austriamicrosystems for availability

**Description:**

AS3691V-CPPD

V ... AS3691 Version, either A or B  
AS3691A: 10mV on VRES<sub>x</sub> (x=1 to 4) if ON<sub>x</sub> = 0 (see '7 Detailed Functional Description')  
AS3691B: 0mV on VRES<sub>x</sub> (x=1 to 4) if ON<sub>x</sub> = 0 (see '7 Detailed Functional Description')

C ... Temperature range -20°C - 85°C

PP ... Package; QF for QFN, SD for sorted DIES, TS for enhanced Power TSSOP

D ... Delivery From; P for Tape&Reel in Dry Pack, F for cut dies on foil, T for Trays in Dry Pack

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