



## TDA9109/N

# LOW-COST DEFLECTION PROCESSOR FOR MULTISYNC MONITORS

### HORIZONTAL

- SELF-ADAPTATIVE
- DUAL PLL CONCEPT
- 150kHz MAXIMUM FREQUENCY
- X-RAY PROTECTION INPUT
- I<sup>2</sup>C CONTROLS : H-POSITION, FREQUENCY GENERATOR FOR BURN-IN MODE

### VERTICAL

- VERTICAL RAMP GENERATOR
- 50 TO 165Hz AGC LOOP
- GEOMETRY TRACKING WITH VPOS & VAMP
- I<sup>2</sup>C CONTROLS :  
VAMP, VPOS, S-CORR, C-CORR
- DC BREATHING COMPENSATION

### I<sup>2</sup>C GEOMETRY CORRECTIONS

- VERTICAL PARABOLA GENERATOR  
(Pincushion, Keystone)
- HORIZONTAL DYNAMIC PHASE  
(Side Pin Balance & Parallelogram)
- HORIZONTAL AND VERTICAL DYNAMIC FOCUS (Horizontal Focus Amplitude, Horizontal Focus Symmetry, Vertical Focus Amplitude)

### GENERAL

- SYNC PROCESSOR
- 12V SUPPLY VOLTAGE
- 8V REFERENCE VOLTAGE
- HOR. & VERT. LOCK/UNLOCK OUTPUTS
- READ/WRITE I<sup>2</sup>C INTERFACE
- VERTICAL MOIRE
- B+ REGULATOR
  - INTERNAL PWM GENERATOR FOR B+ CURRENT MODE STEP-UP CONVERTER
  - SWITCHABLE TO STEP-DOWN CONVERTER
  - I<sup>2</sup>C ADJUSTABLE B+ REFERENCE VOLTAGE
  - OUTPUT PULSES SYNCHRONIZED ON HORIZONTAL FREQUENCY
  - INTERNAL MAX. CURRENT LIMITATION
- COMPARED WITH THE TDA9109, THE TDA9109/N HAS :
  - NO I<sup>2</sup>C FREE RUNNING FREQUENCY ADJUSTMENT
  - FIXED HORIZONTAL DUTY CYCLE (48%)
  - INCREASED MAX. STORAGE TIME OF THE HORIZONTAL SCANNING TRANSISTOR

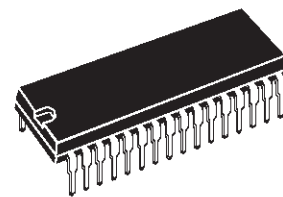
### DESCRIPTION

The TDA9109/N is a monolithic integrated circuit assembled in 32-pin shrink dual in line plastic package. This IC controls all the functions related to the horizontal and vertical deflection in multimode or multi-frequency computer display monitors.

The internal sync processor, combined with the very powerful geometry correction block make the TDA9109/N suitable for very high performance monitors, using very few external components.

The horizontal jitter level is very low. It is particularly well suited for high-end 15" and 17" monitors.

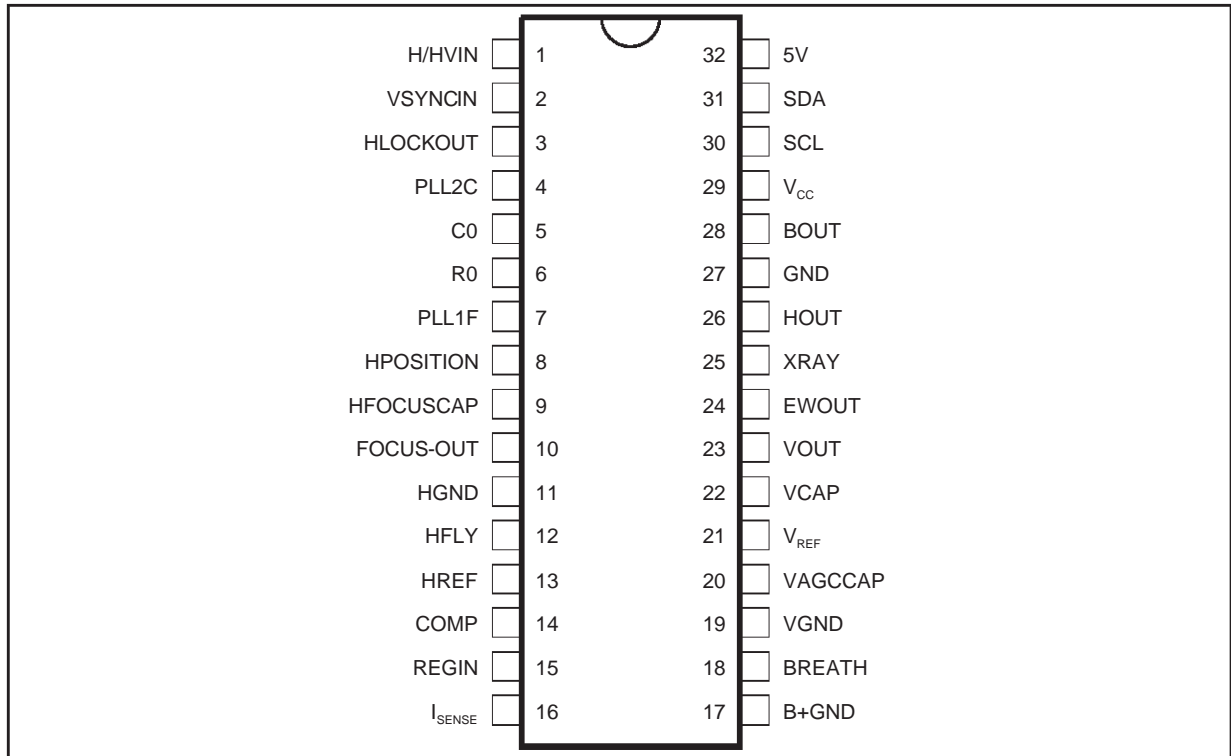
Combined with the ST7275 Microcontroller family, TDA9206 (Video preamplifier) and STV942x (On-Screen Display controller) the TDA9109/N allows fully I<sup>2</sup>C bus controlled computer display monitors to be built with a reduced number of external components.



**SHRINK32**  
(Plastic Package)

**ORDER CODE : TDA9109/N**

PIN CONNECTIONS



9109N-01.EPS

## PIN CONNECTIONS

| Pin | Name            | Function  |
|-----|-----------------|---|
| 1   | H/HVIN          | TTL compatible Horizontal sync Input (separate or composite)  |
| 2   | VSYNCIN         | TTL compatible Vertical sync Input (for separated H&V)  |
| 3   | HLOCKOUT        | First PLL Lock/Unlock Output (0V unlocked - 5V locked)  |
| 4   | PLL2C           | Second PLL Loop Filter  |
| 5   | C0              | Horizontal Oscillator Capacitor   |
| 6   | R0              | Horizontal Oscillator Resistor  |
| 7   | PLL1F           | First PLL Loop Filter   |
| 8   | HPOSITION       | Horizontal Position Filter (capacitor to be connected to HGND)  |
| 9   | HFOCUSCAP       | Horizontal Dynamic Focus Oscillator Capacitor   |
| 10  | FOCUSOUT        | Mixed Horizontal and Vertical Dynamic Focus Output  |
| 11  | HGND            | Horizontal Section Ground   |
| 12  | HFLY            | Horizontal Flyback Input (positive polarity)  |
| 13  | HREF            | Horizontal Section Reference Voltage (to be filtered)   |
| 14  | COMP            | B+ Error Amplifier Output for frequency compensation and gain setting   |
| 15  | REGIN           | Regulation Input of B+ control loop   |
| 16  | ISENSE          | Sensing of external B+ switching transistor current, or switch for step-down converter  |
| 17  | B+GND           | Ground (related to B+ reference adjustment)   |
| 18  | BREATH          | DC Breathing Input Control (compensation of vertical amplitude against EHV variation)   |
| 19  | VGND            | Vertical Section Ground   |
| 20  | VAGCCAP         | Memory Capacitor for Automatic Gain Control Loop in Vertical Ramp Generator   |
| 21  | VREF            | Vertical Section Reference Voltage (to be filtered)   |
| 22  | VCAP            | Vertical Sawtooth Generator Capacitor   |
| 23  | VOUT            | Vertical Ramp Output (with frequency independant amplitude and S or C Corrections if any). It is mixed with vertical position voltage and vertical moiré. |
| 24  | EWOUT           | Pin Cushion - E/W Correction Parabola Output  |
| 26  | HOUT            | Horizontal Drive Output (internal transistor, open collector)   |
| 25  | XRAY            | X-RAY protection input (with internal latch function)   |
| 27  | GND             | General Ground (referenced to V <sub>CC</sub> )   |
| 28  | BOUT            | B+ PWM Regulator Output   |
| 29  | V <sub>CC</sub> | Supply Voltage (12V typ)  |
| 30  | SCL             | I <sup>2</sup> C Clock Input  |
| 31  | SDA             | I <sup>2</sup> C Data Input   |
| 32  | 5V              | Supply Voltage (5V typ.)  |

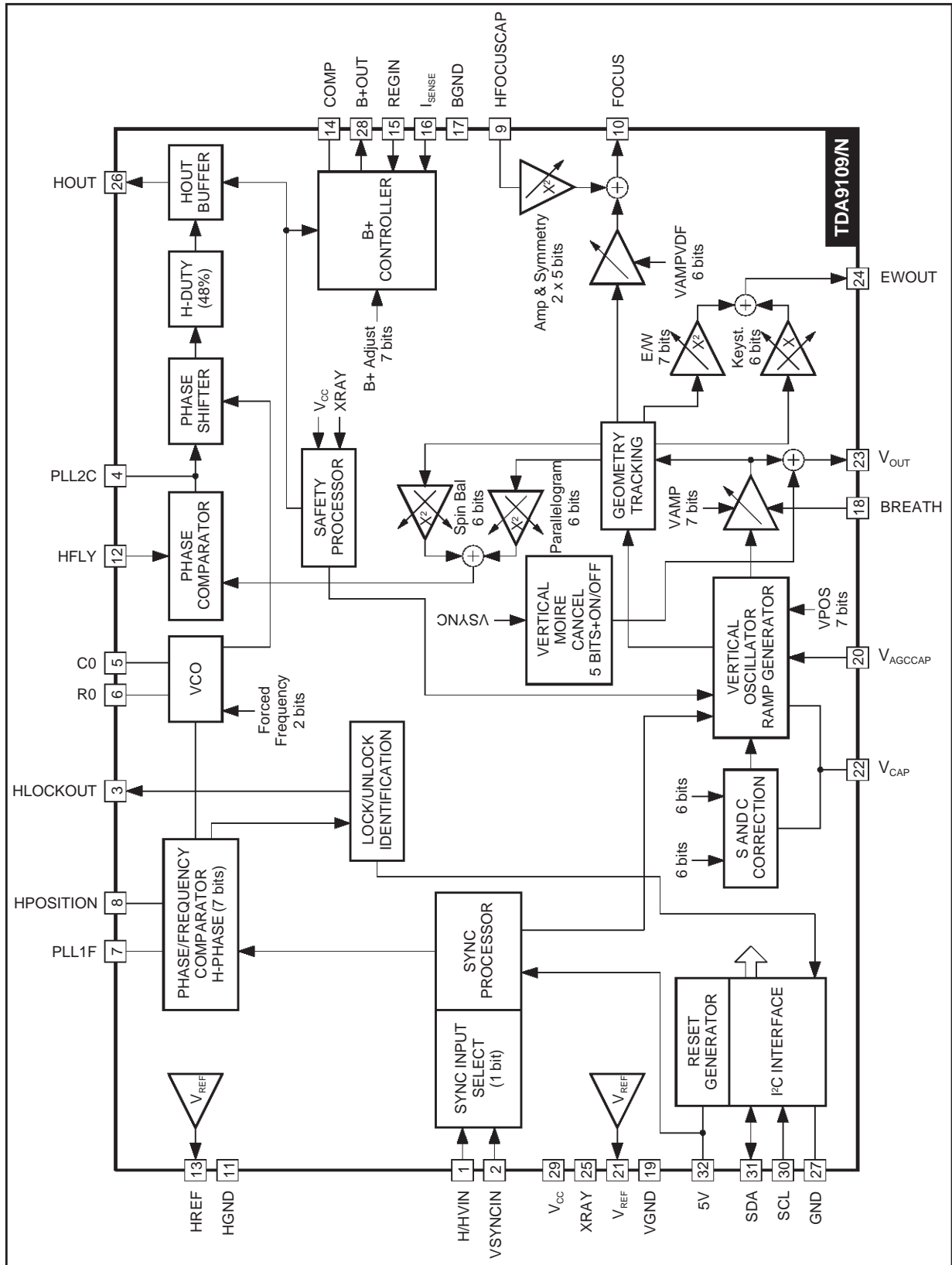
9109N-01.TBL

**QUICK REFERENCE DATA**

| Parameter  | Value       | Unit |
|--|-------------|------|
| Horizontal Frequency   | 15 to 150   | kHz  |
| Autosynch Frequency (for given R0 and C0)                                    | 1 to 4.5 f0 |      |
| æ Horizontal Sync Polarity Input   | YES         |      |
| Polarity Detection (on both Horizontal and Vertical Sections)                | YES         |      |
| TTL Composite Sync   | YES         |      |
| Lock/Unlock Identification (on both Horizontal 1st PLL and Vertical Section) | YES         |      |
| I <sup>2</sup> C Control for H-Position                                      | ± 10        | %    |
| XRAY Protection  | YES         |      |
| Fixed I <sup>2</sup> C Horizontal Duty Cycle                                 | 48          | %    |
| I <sup>2</sup> C Free Running Frequency Adjustment                           | NO          |      |
| Stand-by Function  | YES         |      |
| Dual Polarity H-Drive Outputs  | NO          |      |
| Supply Voltage Monitoring  | YES         |      |
| PLL1 Inhibition Possibility  | NO          |      |
| Blanking Outputs   | NO          |      |
| Vertical Frequency   | 35 to 200   | Hz   |
| Vertical Autosync (for 150nF on Pin 22 and 470nF on Pin 20)                  | 50 to 165   | Hz   |
| Vertical S-Correction  | YES         |      |
| Vertical C-Correction  | YES         |      |
| Vertical Amplitude Adjustment  | YES         |      |
| DC Breathing Control on Vertical Amplitude                                   | YES         |      |
| Vertical Position Adjustment   | YES         |      |
| East/West (E/W) Parabola Output (also known as Pin Cushion Output)           | YES         |      |
| E/W Correction Amplitude Adjustment  | YES         |      |
| Keystone Adjustment  | YES         |      |
| Internal Dynamic Horizontal Phase Control                                    | YES         |      |
| Side Pin Balance Amplitude Adjustment  | YES         |      |
| Parallelogram Adjustment   | YES         |      |
| Tracking of Geometric Corrections with Vertical Amplitude and Position       | YES         |      |
| Reference Voltage (both on Horizontal and Vertical)                          | YES         |      |
| Dynamic Focus (both Horizontal and Vertical)                                 | YES         |      |
| I <sup>2</sup> C Horizontal Dynamic Focus Amplitude Adjustment               | YES         |      |
| I <sup>2</sup> C Horizontal Dynamic Focus Symmetry Adjustment                | YES         |      |
| I <sup>2</sup> C Vertical Dynamic Focus Amplitude Adjustment                 | YES         |      |
| Detection of Input Sync Type (biased from 5V alone)                          | YES         |      |
| Vertical Moiré Output  | YES         |      |
| I <sup>2</sup> C Controlled V-Moiré Amplitude                                | YES         |      |
| Frequency Generator for Burn-in  | YES         |      |
| Fast I <sup>2</sup> C Read/Write   | 400         | kHz  |
| B+ Regulation adjustable by I <sup>2</sup> C                                 | YES         |      |

91109N-02.TBL

BLOCK DIAGRAM



9109N-02.EPS

**ABSOLUTE MAXIMUM RATINGS**

| Symbol            | Parameter  | Value  | Unit                       |
|-------------------|--|--|----------------------------|
| V <sub>CC</sub>   | Supply Voltage (Pin 29)  | 13.5   | V                          |
| V <sub>DD</sub>   | Supply Voltage (Pin 32)  | 5.7  | V                          |
| V <sub>IN</sub>   | Max Voltage on Pin 4<br>Pin 9<br>Pin 5<br>Pins 6, 7, 8, 14, 15, 16, 20, 22<br>Pin 10, 18, 23, 24, 25, 26, 28<br>Pins 1, 2, 3, 30, 31 | 4.0<br>5.5<br>6.4<br>8.0<br>V <sub>CC</sub><br>V <sub>DD</sub> | V<br>V<br>V<br>V<br>V<br>V |
| VESD              | ESD susceptibility Human Body Model, 100pF Discharge through 1.5kΩ<br>EIAJ Norm, 200pF Discharge through 0Ω                          | 2<br>300   | kV<br>V                    |
| T <sub>stg</sub>  | Storage Temperature  | -40, +150  | °C                         |
| T <sub>j</sub>    | Junction Temperature   | +150   | °C                         |
| T <sub>oper</sub> | Operating Temperature  | 0, +70   | °C                         |

9109N-03.TBL

**THERMAL DATA**

| Symbol               | Parameter                                | Value | Unit |
|----------------------|--|-------|------|
| R <sub>th(j-a)</sub> | Junction-Ambient Thermal Resistance Max. | 65    | °C/W |

9109N-04.TBL

**SYNC PROCESSOR**

Operating Conditions (V<sub>DD</sub> = 5V, T<sub>amb</sub> = 25°C)

| Symbol                | Parameter  | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------------------|--|-----------------|------|------|------|------|
| HsVR                  | Voltage on H/HVIN Input                          | Pin 1           | 0    |      | 5    | V    |
| MinD                  | Minimum Horizontal Input Pulses Duration         | Pin 1           | 0.7  |      |      | µs   |
| Mduty                 | Maximum Horizontal Input Signal Duty Cycle       | Pin 1           |      |      | 25   | %    |
| VsVR                  | Voltage on VSYNCIN                               | Pin 2           | 0    |      | 5    | V    |
| VSW                   | Minimum Vertical Sync Pulse Width                | Pin 2           | 5    |      |      | µs   |
| VSmD                  | Maximum Vertical Sync Input Duty Cycle           | Pin 2           |      |      | 15   | %    |
| VextM                 | Maximum Vertical Sync Width on TTL H/V composite | Pin 1           |      |      | 750  | µs   |
| I <sub>HLOCKOUT</sub> | Sink and Source Current                          | Pin3            |      |      | 250  | µA   |

**Electrical Characteristics (V<sub>DD</sub> = 5V, T<sub>amb</sub> = 25°C)**

| Symbol | Parameter   | Test Conditions  | Min. | Typ.   | Max. | Unit   |
|--------|---|--|------|--------|------|--------|
| VINTH  | Horizontal and Vertical Input Logic Level (Pins 1, 2)                                 | Low Level<br>High Level  | 2.2  |        | 0.8  | V<br>V |
| RIN    | Horizontal and Vertical Pull-Up Resistor  | Pins 1, 2  |      | 200    |      | kΩ     |
| TfrOut | Fall and Rise Time, Output CMOS Buffer  | Pin 3, C <sub>OUT</sub> = 20pF   |      |        | 200  | ns     |
| VHlock | Horizontal 1st PLL Lock Output Status (Pin 3)   | Locked, I <sub>LOCKOUT</sub> = -250µA<br>Unlocked, I <sub>LOCKOUT</sub> = +250µA | 4.4  | 0<br>5 | 0.5  | V<br>V |
| VoutT  | Extracted Vsync Integration Time (% of T <sub>H</sub> ) on H/V Composite (see Note 1) | C <sub>0</sub> = 820pF   | 26   | 35     |      | %      |

Note 1 : T<sub>H</sub> is the horizontal period.

**I<sup>2</sup>C READ/WRITE (see Note 2)**

Electrical Characteristics (V<sub>DD</sub> = 5V, T<sub>amb</sub> = 25°C)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
|--------|-----------|-----------------|------|------|------|------|

**I<sup>2</sup>C PROCESSOR**

|       |  |            |     |     |     |     |
|-------|--|------------|-----|-----|-----|-----|
| Fscl  | Maximum Clock Frequency                          | Pin 30     |     |     | 400 | kHz |
| Tlow  | Low period of the SCL Clock                      | Pin 30     | 1.3 |     |     | µs  |
| Thigh | High period of the SCL Clock                     | Pin 30     | 0.6 |     |     | µs  |
| Vinth | SDA and SCL Input Threshold                      | Pins 30,31 |     | 2.2 |     | V   |
| VACK  | Acknowledge Output Voltage on SDA input with 3mA | Pin 31     |     |     | 0.4 | V   |

Note 2 : See also I<sup>2</sup>C Table Control and I<sup>2</sup>C Sub Address Control.

9109N-05.TBL

**HORIZONTAL SECTION****Operating Conditions**

| Symbol               | Parameter                    | Test Conditions | Min. | Typ. | Max. | Unit       |
|----------------------|------------------------------|-----------------|------|------|------|------------|
| VCO                  |                              |                 |      |      |      |            |
| $R_{0(\text{Min.})}$ | Minimum Oscillator Resistor  | Pin 6           | 6    |      |      | k $\Omega$ |
| $C_{0(\text{Min.})}$ | Minimum Oscillator Capacitor | Pin 5           | 390  |      |      | pF         |
| $F_{(\text{Max.})}$  | Maximum Oscillator Frequency |                 |      |      | 150  | kHz        |

**OUTPUT SECTION**

|      |   |                      |  |  |    |    |
|------|---|----------------------|--|--|----|----|
| I12m | Maximum Input Peak Current              | Pin 12               |  |  | 5  | mA |
| HOI  | Horizontal Drive Output Maximum Current | Pin 26, Sunk current |  |  | 30 | mA |

**Electrical Characteristics** ( $V_{CC} = 12V$ ,  $T_{\text{amb}} = 25^{\circ}\text{C}$ )

| Symbol                        | Parameter                                  | Test Conditions  | Min. | Typ. | Max. | Unit |
|-------------------------------|--|------------------|------|------|------|------|
| SUPPLY AND REFERENCE VOLTAGES |  |                  |      |      |      |      |
| $V_{CC}$                      | Supply Voltage                             | Pin 29           | 10.8 | 12   | 13.2 | V    |
| $V_{DD}$                      | Supply Voltage                             | Pin 32           | 4.5  | 5    | 5.5  | V    |
| $I_{CC}$                      | Supply Current                             | Pin 29           |      | 50   |      | mA   |
| $I_{DD}$                      | Supply Current                             | Pin 32           |      | 5    |      | mA   |
| $V_{\text{REF-H}}$            | Horizontal Reference Voltage               | Pin 13, I = -2mA | 7.4  | 8    | 8.6  | V    |
| $V_{\text{REF-V}}$            | Vertical Reference Voltage                 | Pin 21, I = -2mA | 7.4  | 8    | 8.6  | V    |
| $I_{\text{REF-H}}$            | Max. Sourced Current on $V_{\text{REF-H}}$ | Pin 13           |      |      | 5    | mA   |
| $I_{\text{REF-V}}$            | Max. Sourced Current on $V_{\text{REF-V}}$ | Pin 21           |      |      | 5    | mA   |

**1st PLL SECTION**

|                         |  |   |      |                      |    |                     |
|-------------------------|--|---|------|----------------------|----|---------------------|
| HpoIT                   | Delay Time for detecting polarity change (see Note 3)  | Pin 1   | 0.75 |                      |    | ms                  |
| $V_{VCO}$               | VCO Control Voltage (Pin 7)  | $V_{\text{REF-H}} = 8V$<br>$f_0$<br>$f_H(\text{Max.})$  |      | 1.3<br>6.2           |    | V<br>V              |
| Vcog                    | VCO Gain (Pin 7)   | $R_0 = 6.49k\Omega$ , $C_0 = 820pF$ ,<br>$dF/dV = 1/11R_0C_0$   |      | 17.1                 |    | kHz/V               |
| Hph                     | Horizontal Phase Adjustment (see Note 4)   | % of Horizontal Period  |      | $\pm 10$             |    | %                   |
| Vbmin<br>Vbtyp<br>Vbmax | Horizontal Phase Setting Value (Pin 8) (see Note 4)<br>Minimum Value<br>Typical Value<br>Maximum Value | Sub-Address 01<br>Byte x1111111<br>Byte x1000000<br>Byte x0000000   |      | 2.8<br>3.4<br>4.0    |    | V<br>V<br>V         |
| IP11U<br>IP11L          | PLL1 Filter Current Charge   | PLL1 is Unlocked<br>PLL1 is Locked  |      | $\pm 140$<br>$\pm 1$ |    | $\mu\text{A}$<br>mA |
| $f_0$                   | Free Running Frequency   | $R_0 = 6.49k\Omega$ , $C_0 = 820pF$ ,<br>$f_0 = 0.97/8R_0C_0$   |      | 22.8                 |    | kHz                 |
| df0/dT                  | Free Running Frequency Thermal Drift (No drift on external components) (see Note 5)                    |   |      | -150                 |    | ppm/C               |
| CR                      | PLL1 Capture Range (see Note 6)  | $R_0 = 6.49k\Omega$ , $C_0 = 820pF$ ,<br>from $f_0 + 0.5\text{kHz}$ to $4.5f_0$<br>$f_H(\text{Min.})$<br>$f_H(\text{Max.})$ | 90   |                      | 25 | kHz<br>kHz          |
| FF                      | Forced Frequency<br>FF1 Byte 11xxxxxx<br>FF2 Byte 10xxxxxx   | Sub-Address 02  |      | 2f0<br>3f0           |    |                     |

Notes : 3. This delay is mandatory to avoid a wrong detection of polarity change in the case of a composite sync.

4. See Figure 10 for explanation of reference phase.

5. These parameters are not tested on each unit. They are measured during our internal qualification.

6. This PLL capture range may be obtained only if  $f_0$  is adjusted (for instance by adjusting  $R_0$ ). If not, more margin must be provided between  $f_H(\text{Min.})$  and  $f_0$ , to cope with the components spread.

**HORIZONTAL SECTION** (continued)**Electrical Characteristics** ( $V_{CC} = 12V$ ,  $T_{amb} = 25^{\circ}C$ ) (continued)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
|--------|-----------|-----------------|------|------|------|------|

## 2nd PLL SECTION AND HORIZONTAL OUTPUT SECTION

|        |  |                          |      |            |     |        |
|--------|--|--------------------------|------|------------|-----|--------|
| FBth   | Flyback Input Threshold Voltage (Pin 12)   |                          | 0.65 | 0.75       |     | V      |
| Hjit   | Horizontal Jitter  | At 31.4kHz               |      | 70         |     | ppm    |
| HD     | Horizontal Drive Output Duty-Cycle   | Pin 26, see Note 7       |      | 48         |     | %      |
| XRAYth | X-RAY Protection Input Threshold Voltage   | Pin 25, see Note 8       |      | 8          |     | V      |
| Vphi2  | Internal Clamping Levels on 2nd PLL Loop Filter (Pin 4)  | Low Level<br>High Level  |      | 1.6<br>4.0 |     | V<br>V |
| VSCinh | Threshold Voltage to Stop H-Out, V-Out, B-Out and Reset XRAY when $V_{CC} < VSCinh$ (see Note 8) | Pin 29                   |      | 7.5        |     | V      |
| HDvd   | Horizontal Drive Output (low level)  | Pin 26, $I_{OUT} = 30mA$ |      |            | 0.4 | V      |

## HORIZONTAL DYNAMIC FOCUS FUNCTION

|          |  |   |            |                   |  |                                  |
|----------|--|---|------------|-------------------|--|----------------------------------|
| HDFst    | Horizontal Dynamic Focus Sawtooth Minimum Level<br>Maximum Level   | Pin 9, capacitor on HFOCUSCAP and $C_0 = 820pF$ , $T_H = 20\mu s$ |            | 2<br>4.7          |  | V<br>V                           |
| HDFdis   | Horizontal Dynamic Focus Sawtooth Discharge Width  | Start by HFLY center  |            | 400               |  | ns                               |
| HDFDC    | Bottom DC Output Level   | $R_{LOAD} = 10k\Omega$ , Pin 10                                   |            | 2                 |  | V                                |
| TDHDF    | DC Output Voltage Thermal Drift (see Note 5)   |   |            | 200               |  | ppm/C                            |
| HDFamp   | Horizontal Dynamic Focus Amplitude<br>Min Byte xxx11111<br>Typ Byte xxx10000<br>Max Byte xxx00000            | Sub-Address 03, Pin 10, $f_H = 50kHz$ , Symmetry Typ.             |            | 1<br>1.5<br>3     |  | $V_{PP}$<br>$V_{PP}$<br>$V_{PP}$ |
| HDFkeyst | Horizontal Dynamic Focus Symmetry<br><br>Min A/B Byte xxx11111<br>Typ Byte xxx10000<br>Max A/B Byte xxx00000 | Sub-Address 04, $f_H = 50kHz$ ,<br>Typ. Amp<br>B/A<br>A/B<br>A/B  | 2<br><br>2 | 3.5<br>1.0<br>3.5 |  |                                  |

## VERTICAL DYNAMIC FOCUS FUNCTION (positive parabola)

|          |  |   |  |                 |  |                                  |
|----------|--|---|--|-----------------|--|----------------------------------|
| AMPVDF   | Vertical Dynamic Focus Parabola (added to horizontal) Amplitude with VAMP and VPOS Typical<br>Min. Byte 000000<br>Typ. Byte 100000<br>Max. Byte 111111 | Sub-Address 0F  |  | 0<br>0.5<br>1   |  | $V_{PP}$<br>$V_{PP}$<br>$V_{PP}$ |
| VDFAMP   | Parabola Amplitude Function of VAMP (tracking between VAMP and VDF) with VPOS Typ. (see Figure 1 and Note 9)   | Sub-Address 05<br>Byte 10000000<br>Byte 11000000<br>Byte 11111111 |  | 0.6<br>1<br>1.5 |  | $V_{PP}$<br>$V_{PP}$<br>$V_{PP}$ |
| VHDFKeyt | Parabola Asymetry Function of VPOS Control (tracking between VPOS and VDF) with VAMP Max.  | Sub-Address 06<br>Byte x0000000<br>Byte x1111111                  |  | 0.52<br>0.52    |  | $V_{PP}$<br>$V_{PP}$             |

Notes: 5. These parameters are not tested on each unit. They are measured during our internal qualification.

7. Duty Cycle is the ratio between the output transistor OFF time and the period. The power transistor is controlled OFF when the output transistor is OFF.

8. See Figure 14.

9. S and C correction are inhibited so the output sawtooth has a linear shape.



## VERTICAL SECTION

### Operating Conditions

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
|--------|-----------|-----------------|------|------|------|------|

#### OUTPUTS SECTION

|                   |  |        |     |  |     |    |
|-------------------|--|--------|-----|--|-----|----|
| VEWM              | Maximum E/W Output Voltage                             | Pin 24 |     |  | 6.5 | V  |
| VEWm              | Minimum E/W Output Voltage                             | Pin 24 | 1.8 |  |     | V  |
| R <sub>LOAD</sub> | Minimum Load for less than 1% Vertical Amplitude Drift | Pin 20 | 65  |  |     | MΩ |

### Electrical Characteristics (V<sub>CC</sub> = 12V, T<sub>amb</sub> = 25°C)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
|--------|-----------|-----------------|------|------|------|------|

#### VERTICAL RAMP SECTION

|       |  |  |      |                   |     |             |
|-------|--|--|------|-------------------|-----|-------------|
| VRB   | Voltage at Ramp Bottom Point   | V <sub>REF-V</sub> = 8V, Pin 22  |      | 2                 |     | V           |
| VRT   | Voltage at Ramp Top Point (with Sync)  | V <sub>REF-V</sub> = 8V, Pin 22  |      | 5                 |     | V           |
| VRTF  | Voltage at Ramp Top Point (without Sync)   | Pin 22   |      | VRT-0.1           |     | V           |
| VSTD  | Vertical Sawtooth Discharge Time   | Pin 22, C <sub>22</sub> = 150nF  |      | 70                |     | μs          |
| VFRF  | Vertical Free Running Frequency (see Note 10)  | C <sub>OSC (Pin 22)</sub> = 150nF<br>Measured on Pin22   |      | 100               |     | Hz          |
| ASFR  | AUTO-SYNC Frequency (see Note 11)  | C <sub>22</sub> = 150nF ±5%  | 50   |                   | 165 | Hz          |
| RAFD  | Ramp Amplitude Drift Versus Frequency at Maximum Vertical Amplitude (see Note 5)                           | C <sub>22</sub> = 150nF<br>50Hz < f and f < 165Hz  |      | 200               |     | ppm/Hz      |
| Rlin  | Ramp Linearity on Pin 22 (see Note 10)   | 2.5V < V <sub>27</sub> and V <sub>27</sub> < 4.5V  |      | 0.5               |     | %           |
| VPOS  | Vertical Position Adjustment Voltage (Pin 23 - VOUT mean value)  | Sub Address 06<br>Byte x0000000<br>Byte x1000000<br>Byte x1111111                              | 3.65 | 3.2<br>3.5<br>3.8 | 3.3 | V<br>V<br>V |
| VOR   | Vertical Output Voltage (peak-to-peak on Pin 23)   | Sub Address 05<br>Byte x0000000<br>Byte x1000000<br>Byte x1111111                              | 3.5  | 2.25<br>3<br>3.75 | 2.5 | V<br>V<br>V |
| VOI   | Vertical Output Maximum Current (Pin 23)   |  |      | ±5                |     | mA          |
| dVS   | Max Vertical S-Correction Amplitude (see Note 12)<br>x0xxxxxx inhibits S-CORR<br>x1111111 gives max S-CORR | Sub Address 07<br><br>ΔV/V <sub>PP</sub> at TV/4<br>ΔV/V <sub>PP</sub> at 3TV/4                |      | -4<br>+4          |     | %<br>%      |
| Ccorr | Vertical C-Corr Amplitude<br>x0xxxxxx inhibits C-CORR  | Sub Address 08<br>ΔV/V <sub>PP</sub> @ TV/2<br>Byte x1000000<br>Byte x1100000<br>Byte x1111111 |      | -3<br>0<br>3      |     | %<br>%<br>% |

- Notes : 5. These parameters are not tested on each unit. They are measured during our internal qualification.  
 10. With Register 07 at Byte x0xxxxxx (S correction is inhibited) and with Register 08 at Byte x0xxxxxx (C correction is inhibited), the sawtooth has a linear shape.  
 11. This is the frequency range for which the vertical oscillator will automatically synchronize, using a single capacitor value on Pin 22 and with a constant ramp amplitude.  
 12. TV is the vertical period.

9109N-05.TBL

**VERTICAL SECTION** (continued)

**Electrical Characteristics** ( $V_{CC} = 12V$ ,  $T_{amb} = 25^{\circ}C$ ) (continued)

| Symbol   | Parameter  | Test Conditions  | Min. | Typ.                 | Max. | Unit  |
|--|--|--|------|----------------------|------|---|
| <b>East/West (E/W) FUNCTION</b>                  |  |  |      |                      |      |   |
| EW <sub>DC</sub>                                 | DC Output Voltage with Typ. VPOS and Keystone inhibited  | Pin 24, see Figure 2   |      | 2.5                  |      | V   |
| TDEW <sub>DC</sub>                               | DC Output Voltage Thermal Drift  | See Note 13  |      | 100                  |      | ppm/C   |
| EW <sub>para</sub>                               | Parabola Amplitude with Max. VAMP, Typ. VPOS, Keystone inhibited   | Subaddress 0A<br>Byte 11111111<br>Byte 11000000<br>Byte 10000000 |      | 2.5<br>1.25<br>0     |      | V <sub>PP</sub><br>V <sub>PP</sub><br>V <sub>PP</sub> |
| EW <sub>track</sub>                              | Parabola Amplitude Function of VAMP Control (tracking between VAMP and E/W) with Typ. VPOS, Typ. E/W Amplitude and Keystone inhibited (see Note 10)                                  | Subaddress 05<br>Byte 10000000<br>Byte 11000000<br>Byte 11111111 |      | 0.45<br>0.8<br>1.25  |      | V <sub>PP</sub><br>V <sub>PP</sub><br>V <sub>PP</sub> |
| KeyAdj   | Keystone Adjustment Capability with Typ. VPOS, E/W inhibited and Max. Vertical Amplitude (see Note 10 and Figure 4)  | Subaddress 09<br>Byte 1x000000<br>Byte 1x111111                  |      | 1<br>1               |      | V <sub>PP</sub><br>V <sub>PP</sub>                    |
| KeyTrack   | Intrinsic Keystone Function of VPOS Control (tracking between VPOS and E/W) with Max. E/W Amplitude and Max. Vertical Amplitude (see Note 13)<br>A/B Ratio<br>B/A Ratio              | Subaddress 06<br><br>Byte x0000000<br>Byte x1111111              |      | <br><br>0.52<br>0.52 |      |   |
| <b>INTERNAL DYNAMIC HORIZONTAL PHASE CONTROL</b> |  |  |      |                      |      |   |
| SPB <sub>para</sub>                              | Side Pin Balance Parabola Amplitude (Figure 3) with Max. VAMP, Typ. VPOS and Parallelogram inhibited (see Notes 10 & 14)   | Subaddress 0D<br>Byte x1111111<br>Byte x1000000                  |      | +1.4<br>-1.4         |      | %T <sub>H</sub><br>%T <sub>H</sub>                    |
| SPB <sub>track</sub>                             | Side Pin Balance Parabola Amplitude function of VAMP Control (tracking between VAMP and SPB) with Max. SPB, Typ. VPOS and Parallelogram inhibited (see Notes 10 & 14)                | Subaddress 05<br>Byte 10000000<br>Byte 11000000<br>Byte 11111111 |      | 0.5<br>0.9<br>1.4    |      | %T <sub>H</sub><br>%T <sub>H</sub><br>%T <sub>H</sub> |
| ParAdj   | Parallelogram Adjustment Capability with Max. VAMP, Typ. VPOS and Max. SPB (see Notes 10 & 14)   | Subaddress 0E<br>Byte x1111111<br>Byte x1000000                  |      | +1.4<br>-1.4         |      | %T <sub>H</sub><br>%T <sub>H</sub>                    |
| Par <sub>track</sub>                             | Intrinsic Parallelogram Function of VPOS Control (tracking between VPOS and DHPC) with Max. VAMP, Max. SPB and Parallelogram inhibited (see Notes 10 & 14)<br>A/B Ratio<br>B/A Ratio | Subaddress 06<br><br>Byte x0000000<br>Byte x1111111              |      | <br><br>0.52<br>0.52 |      |   |
| <b>VERTICAL MOIRE</b>                            |  |  |      |                      |      |   |
| VMOIRE   | Vertical Moiré (measured on VOUT : Pin 23)   | Subaddress 0C<br>Byte 01x11111                                   |      | 6                    |      | mV  |
| <b>BREATHING COMPENSATION</b>                    |  |  |      |                      |      |   |
| BRRANG   | DC Breathing Control Range (see Note 15)   | V18  | 1    |                      | 12   | V   |
| BRADj  | Vertical Output Variation versus DC Breathing Control (Pin 23)   | $V_{18} \geq V_{REF-V}$<br>$V_{18} = 4V$                         |      | 0<br>-10             |      | %<br>%  |

Notes : 10. With Register 07 at Byte x0xxxxx (S correction is inhibited) and with Register 08 at Byte x0xxxxx (C correction is inhibited), the sawtooth has a linear shape.  
 13. These parameters are not tested on each unit. They are measured during our internal qualification.  
 14. T<sub>H</sub> is the horizontal period.  
 15. When not used the DC breathing control pin must be connected to 12V.

9109N-05.TBL

**B+ SECTION**  
**Operating Conditions**

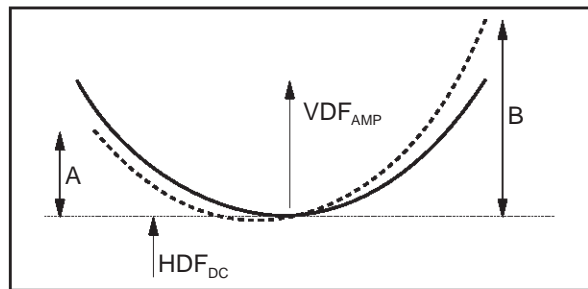
| Symbol  | Parameter                 | Test conditions                 | Min. | Typ. | Max. | Unit |
|---------|---------------------------|---------------------------------|------|------|------|------|
| FeedRes | Minimum Feedback Resistor | Resistor between Pins 15 and 14 | 5    |      |      | kΩ   |

**Electrical Characteristics** ( $V_{CC} = 12V, T_{amb} = 25^{\circ}C$ )

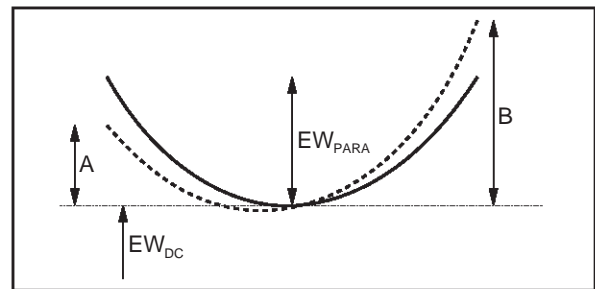
| Symbol              | Parameter  | Test conditions   | Min. | Typ.       | Max.     | Unit     |
|---------------------|--|---|------|------------|----------|----------|
| OLG                 | Error Amplifier Open Loop Gain                   | At low frequency (see Note 16)                          |      | 85         |          | dB       |
| UGBW                | Unity Gain Bandwidth                             | (see Note 16)   |      | 6          |          | MHz      |
| IRI                 | Regulation Input Bias Current                    | Current sourced by Pin 15 (PNP base)                    |      | 0.2        |          | μA       |
| EAOI                | Error Amplifier Output Current                   | Current sourced by Pin 14<br>Current sunk by Pin 14     |      |            | 0.5<br>2 | mA<br>mA |
| CSG                 | Current Sense Input Voltage Gain                 | Pin 16  |      | 3          |          |          |
| MCEth               | Max Current Sense Input Threshold Voltage        | Pin 16  |      | 1.2        |          | V        |
| ISI                 | Current Sense Input Bias Current                 | Current sunk by Pin 16 (NPN base)                       |      | 1          |          | μA       |
| Tonmax              | Maximum ON Time of the external power transistor | % of Horizontal period,<br>$f_0 = 27kHz$ (see Note 17)  |      | 100        |          | %        |
| B+OSV               | B+ Output Saturation Voltage                     | $V_{28}$ with $I_{28} = 10mA$                           |      | 0.25       |          | V        |
| IV <sub>REF</sub>   | Internal Reference Voltage                       | On erroramp (+) input for Subaddress 0B<br>Byte 1000000 |      | 4.8        |          | V        |
| V <sub>REFADJ</sub> | Internal Reference Voltage Adjustment Range      | Byte 1111111<br>Byte 0000000                            |      | +20<br>-20 |          | %<br>%   |
| PWMSEL              | Threshold for step-up/step-down selection        | Pin 16  |      | 6          |          | V        |
| t <sub>FB+</sub>    | Fall Time  | Pin 28  |      | 100        |          | ns       |

Notes : 16. These parameters are not tested on each unit. They are measured during our internal qualification procedure which includes characterization on batches coming from corners of our processes and also temperature characterization.  
17. The external power transistor is OFF during 400ns of the HF0CUSCAP discharge.

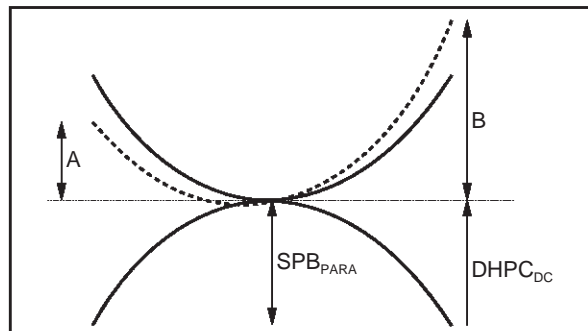
**Figure 1 : Vertical Dynamic Focus Function**



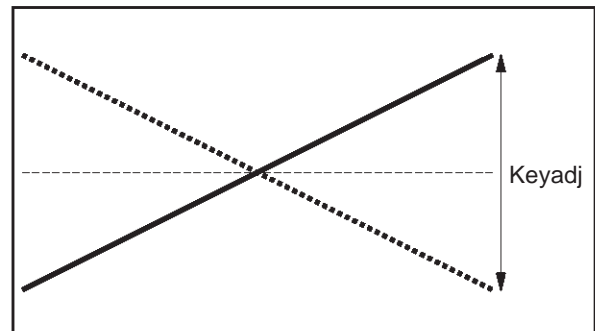
**Figure 2 : E/W Output**



**Figure 3 : Dynamic Horizontal Phase Control Output**



**Figure 4 : Keystone Effect on E/W Output (PCC Inhibited)**

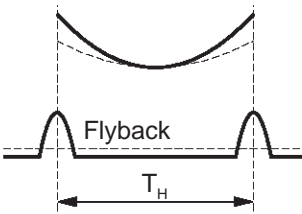
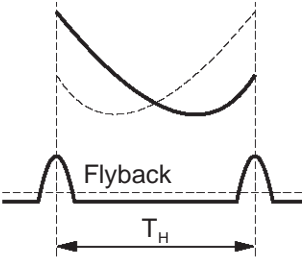
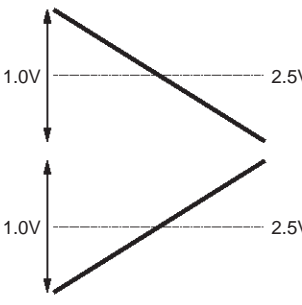

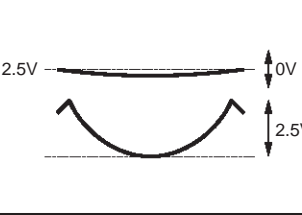

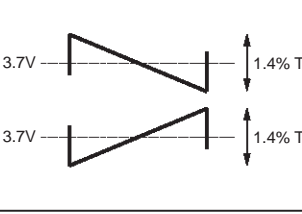

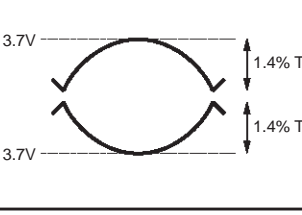

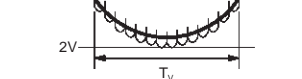


TYPICAL VERTICAL OUTPUT WAVEFORMS

| Function                     | Sub Address | Pin | Byte                             | Specification  | Effect on Screen |
|------------------------------|-------------|-----|----------------------------------|--|------------------|
| Vertical Size                | 05          | 23  | 10000000<br>11111111             |  |                  |
| Vertical Position DC Control | 06          | 23  | x0000000<br>x1000000<br>x1111111 | $V_{OUTDC} = 3.2V$<br>$V_{OUTDC} = 3.5V$<br>$V_{OUTDC} = 3.8V$ |                  |
| Vertical S Linearity         | 07          | 23  | 0xxxxxxx Inhibited<br>1x111111   |  |                  |
| Vertical C Linearity         | 08          | 23  | 1x000000<br>1x111111             |  |                  |

9108N-06.TBL / 9108N-07.EPS TO 9108N-13.EPS

## GEOMETRY OUTPUT WAVEFORMS

| Function                                     | Sub Address | Pin      | Byte  | Specification  | Effect on Screen  |
|--|-------------|----------|---|--|---|
| Horizontal Dynamic Focus with :<br>Amplitude | 03          | 10       |   |    |   |
| Horizontal Dynamic Focus with :<br>Symmetry  | 04          | 10       |   |    |   |
| Keystone (Trapezoid) Control                 | 09          | 24       | E/W Inhibited<br>1x000000<br><br>1x111111           |   |   |
| E/W (Pin Cushion) Control                    | 0A          | 24       | Keystone Inhibited<br>10000000<br><br>11111111      |  |  |
| Parallelogram Control                        | 0E          | Internal | SPB Inhibited<br>1x000000<br><br>1x111111           |  |  |
| Side Pin Balance Control                     | 0D          | Internal | Parallelogram Inhibited<br>1x000000<br><br>1x111111 |  |  |
| Vertical Dynamic Focus with Horizontal       | 0F          | 10       |   |  |   |

9109N-07.TBL / 9109N-14.EPS TO 9109N-24.EPS

**I<sup>2</sup>C BUS ADDRESS TABLE****Slave Address (8C) : Write Mode**

Sub Address Definition

|   | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 |  |
|---|----|----|----|----|----|----|----|----|--|
| 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | Horizontal Drive Selection                 |
| 1 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | Horizontal Position                        |
| 2 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | Forced Frequency                           |
| 3 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | Sync Priority / Horizontal Focus Amplitude |
| 4 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | Refresh / Horizontal Focus Keystone        |
| 5 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 1  | Vertical Ramp Amplitude                    |
| 6 | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | Vertical Position Adjustment               |
| 7 | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1  | S Correction                               |
| 8 | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | C Correction                               |
| 9 | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 1  | E/W Keystone                               |
| A | 0  | 0  | 0  | 0  | 1  | 0  | 1  | 0  | E/W Amplitude                              |
| B | 0  | 0  | 0  | 0  | 1  | 0  | 1  | 1  | B+ Reference Adjustment                    |
| C | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | Vertical Moiré                             |
| D | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 1  | Side Pin Balance                           |
| E | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 0  | Parallelogram                              |
| F | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 1  | Vertical Dynamic Focus Amplitude           |

**Slave Address (8D) : Read Mode**

No sub address needed.

I<sup>2</sup>C BUS ADDRESS TABLE (continued)

|            | D8                               | D7                                 | D6                        | D5                       | D4                     | D3                      | D2                     | D1                   |
|------------|----------------------------------|------------------------------------|---------------------------|--------------------------|------------------------|-------------------------|------------------------|----------------------|
| WRITE MODE |                                  |                                    |                           |                          |                        |                         |                        |                      |
| 00         |                                  | HDrive<br>0, off<br>[1], on        |                           |                          |                        |                         |                        |                      |
| 01         | Xray<br>1, reset<br>[0]          | Horizontal Phase Adjustment        |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 02         | Forced Frequency                 |                                    |                           |                          |                        |                         |                        |                      |
|            | 1, on<br>[0], off                | 1, f0 x 2<br>[0], f0 x 3           |                           |                          |                        |                         |                        |                      |
| 03         | Sync<br>0, Comp<br>[1], Sep      | Horizontal Focus Amplitude         |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 04         | Detect<br>Refresh<br>[0], off    | Horizontal Focus Keystone          |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 05         | Vramp<br>0, off<br>[1], on       | Vertical Ramp Amplitude Adjustment |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 06         | Vertical Position Adjustment     |                                    |                           |                          |                        |                         |                        |                      |
|            | [1]                              | [0]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 07         | S Select<br>1, on<br>[0]         | S Correction                       |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 08         | C Select<br>1, on<br>[0]         | C Correction                       |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 09         | E/W Key<br>0, off<br>[1]         | E/W Keystone                       |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 0A         | E/W Sel<br>0, off<br>[1]         | E/W Amplitude                      |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 0B         | Test H<br>1, on<br>[0], off      | B+ Reference Adjustment            |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 0C         | Test V<br>1, on<br>[0], off      | Moiré<br>1, on<br>[0]              | Vertical Moiré            |                          |                        |                         |                        |                      |
|            |                                  |                                    | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 0D         | SPB Sel<br>0, off<br>[1]         | Side Pin Balance                   |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 0E         | Parallelo<br>0, off<br>[1]       | Parallelogram                      |                           |                          |                        |                         |                        |                      |
|            |                                  | [1]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| 0F         | Vertical Dynamic Focus Amplitude |                                    |                           |                          |                        |                         |                        |                      |
|            | [1]                              | [0]                                | [0]                       | [0]                      | [0]                    | [0]                     | [0]                    | [0]                  |
| READ MODE  |                                  |                                    |                           |                          |                        |                         |                        |                      |
|            | Hlock<br>0, on<br>[1], no        | Vlock<br>0, on<br>[1], no          | Xray<br>1, on<br>[0], off | Polarity Detection       |                        | Sync Detection          |                        |                      |
|            |                                  |                                    |                           | H/V pol<br>[1], negative | V pol<br>[1], negative | Vext det<br>[0], no det | H/V det<br>[0], no det | V det<br>[0], no det |

[ ] initial value

Data is transferred with vertical sawtooth retrace.

We recommend to set the unspecified bit to [0] in order to assure the compatibility with future devices.

## OPERATING DESCRIPTION

### I - GENERAL CONSIDERATIONS

#### I.1 - Power Supply

The typical values of the power supply voltages  $V_{CC}$  and  $V_{DD}$  are 12V and 5V respectively. Optimum operation is obtained for  $V_{CC}$  between 10.8 and 13.2V and  $V_{DD}$  between 4.5 and 5.5V.

In order to avoid erratic operation of the circuit during the transient phase of  $V_{CC}$  switching on, or off, the value of  $V_{CC}$  is monitored : if  $V_{CC}$  is less than 7.5V typ., the outputs of the circuit are inhibited.

Similarly, before  $V_{DD}$  reaches 4V, all the I<sup>2</sup>C register are reset to their default value (see I<sup>2</sup>C Control Table).

In order to have very good power supply rejection, the circuit is internally supplied by several voltage references (typ. value : 8V). Two of these voltage references are externally accessible, one for the vertical and one for the horizontal part. They can be used to bias external circuitry (if  $I_{LOAD}$  is less than 5mA). It is necessary to filter the voltage references by external capacitors connected to ground, in order to minimize the noise and consequently the "jitter" on vertical and horizontal output signals.

#### I.2 - I<sup>2</sup>C Control

TDA9109/N belongs to the I<sup>2</sup>C controlled device family. Instead of being controlled by DC voltages on dedicated control pins, each adjustment can be done via the I<sup>2</sup>C Interface.

The I<sup>2</sup>C bus is a serial bus with a clock and a data input. The general function and the bus protocol are specified in the Philips-bus data sheets.

The interface (Data and Clock) is a comparator with hysteresis ; the thresholds (less than 2.2V on rising edge, more than 0.8V on falling edge with 5V supply) are TTL-compatible. Spikes of up to 50ns are filtered by an integrator and the maximum clock speed is limited to 400kHz.

The data line (SDA) can be used bidirectionally. In read-mode the IC sends reply information (1 byte) to the micro-processor.

The bus protocol prescribes a full-byte transmission in all cases. The first byte after the start condition is used to transmit the IC-address (hexa 8C for write, 8D for read).

#### I.3 - Write Mode

In write mode the second byte sent contains the subaddress of the selected function to adjust (or controls to affect) and the third byte the corresponding data byte. It is possible to send more than one data byte to the IC. If after the third byte no stop or start condition is detected, the circuit increments automatically by one the momentary subaddress in the subaddress counter (auto-increment mode). So it is possible to transmit immediately the following data bytes without sending the IC address or subaddress. This can be useful to reinitialize all the controls very quickly (flash manner). This procedure can be finished by a stop condition.

The circuit has 14 adjustment capabilities: 1 for the horizontal part, 4 for the vertical, 2 for the E/W correction, 2 for the dynamic horizontal phase control, 1 for the Moiré option, 3 for the horizontal and the vertical dynamic focus and 1 for the B+ reference adjustment.

17 bits are also dedicated to several controls (ON/OFF, Horizontal Forced Frequency, Sync Priority, Detection Refresh and XRAY reset).

#### I.4 - Read Mode

During the read mode the second byte transmits the reply information.

The reply byte contains the horizontal and vertical lock/unlock status, the XRAY activation status and, the horizontal and vertical polarity detection. It also contains the sync detection status which is used by the MCU to assign the sync priority.

A stop condition always stops all the activities of the bus decoder and switches to high impedance both the data and clock line (SDA and SCL). See I<sup>2</sup>C subaddress and control tables.

#### I.5 - Sync Processor

The internal sync processor allows the TDA9109/N to accept :

- separated horizontal & vertical TTL-compatible sync signal,
- composite horizontal & vertical TTL-compatible sync signal.



**OPERATING DESCRIPTION** (continued)**I.6 - Sync Identification Status**

The MCU can read (address read mode : 8D) the status register via the I<sup>2</sup>C bus, and then select the sync priority depending on this status.

Among other data this register indicates the presence of sync pulses on H/HVIN, VSYNCIN and (when 12V is supplied) whether a Vext has been extracted from H/HVIN. Both horizontal and vertical sync are detected even if only 5V is supplied.

In order to choose the right sync priority the MCU may proceed as follows (see I<sup>2</sup>C Address Table) :

- refresh the status register,
- wait at least for 20ms (Max. vertical period),
- read this status register.

Sync priority choice should be :

| Vext det | H/V det | V det | Sync priority Subaddress 03 (D8) | Comment Sync type |
|----------|---------|-------|----------------------------------|-------------------|
| No       | Yes     | Yes   | 1                                | Separated H & V   |
| Yes      | Yes     | No    | 0                                | Composite TTL H&V |

Of course, when the choice is made, we can refresh the sync detections and verify that the extracted Vsync is present and that no sync type change has occurred. The sync processor also gives sync polarity information.

**I.7 - IC status**

The IC can inform the MCU about the 1st horizontal PLL and vertical section status (locked or not) and about the XRAY protection (activated or not).

Resetting the XRAY internal latch can be done either by decreasing the V<sub>CC</sub> supply or directly resetting it via the I<sup>2</sup>C interface.

**I.8 - Sync Inputs**

Both H/HVIN and VSYNCIN inputs are TTL compatible triggers with hysteresis to avoid erratic detection. Both inputs include a pull up resistor connected to V<sub>DD</sub>.

**I.9 - Sync Processor Output**

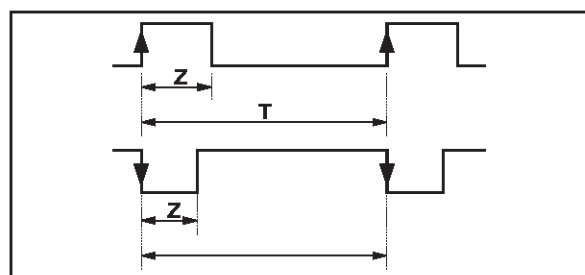
The sync processor indicates on the HLOCKOUT Pin whether 1st PLL is locked to an incoming horizontal sync. HLOCKOUT is a TTL compatible

CMOS output. Its level goes to high when locked. In the same time the D8 bit of the status register is set to 0.

This information is mainly used to trigger safety procedures (like reducing B+ value) as soon as a change is detected on the incoming sync.

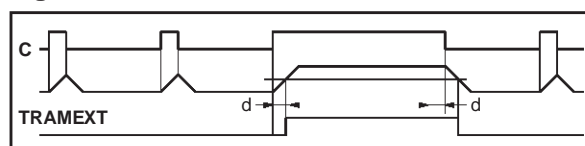
**II - HORIZONTAL PART****II.1 - Internal Input Conditions**

A digital signal (horizontal sync pulse or TTL composite) is sent by the sync processor to the horizontal input. It may be positive or negative (see Figure 5).

**Figure 5**

Using internal integration, both signals are recognized if  $Z/T < 25\%$ . Synchronization occurs on the leading edge of the internal sync signal. The minimum value of Z is 0.7μs.

Another integration is able to extract the vertical pulse from composite sync if the duty cycle is higher than 25% (typically  $d = 35\%$ ) (see Figure 6).

**Figure 6**

The last feature performed is the removal of equalization pulses to avoid parasitic pulses on the phase comparator (which would be disturbed by missing or extraneous pulses).

**OPERATING DESCRIPTION** (continued)

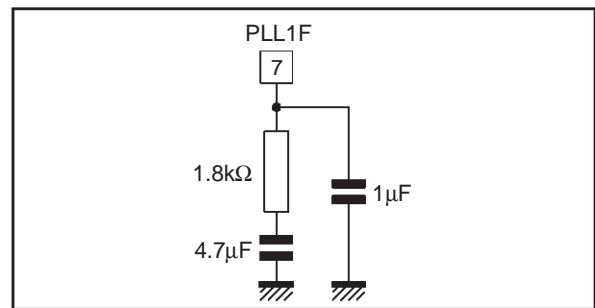
**II.2 - PLL1**

The PLL1 consists of a phase comparator, an external filter and a voltage-controlled oscillator (VCO). The phase comparator is a "phase frequency" type designed in CMOS technology. This kind of phase detector avoids locking on wrong frequencies. It is followed by a "charge pump", composed of two current sources : sunk and sourced (typically  $I = 1\text{mA}$  when locked and  $I = 140\mu\text{A}$  when unlocked). This difference between lock/unlock allows smooth catching of the horizontal frequency by PLL1. This effect is reinforced by an internal original slow down system when PLL1 is locked, avoiding the horizontal frequency changing too quickly. The dynamic behaviour of PLL1 is fixed by an external filter which integrates the current of the charge pump. A "CRC" filter is generally used (see Figure 7).

The PLL1 is internally inhibited during extracted vertical sync (if any) to avoid taking in account missing pulses or wrong pulses on phase comparator. The inhibition is done by a switch located between the charge pump and the filter (see Figure 8).

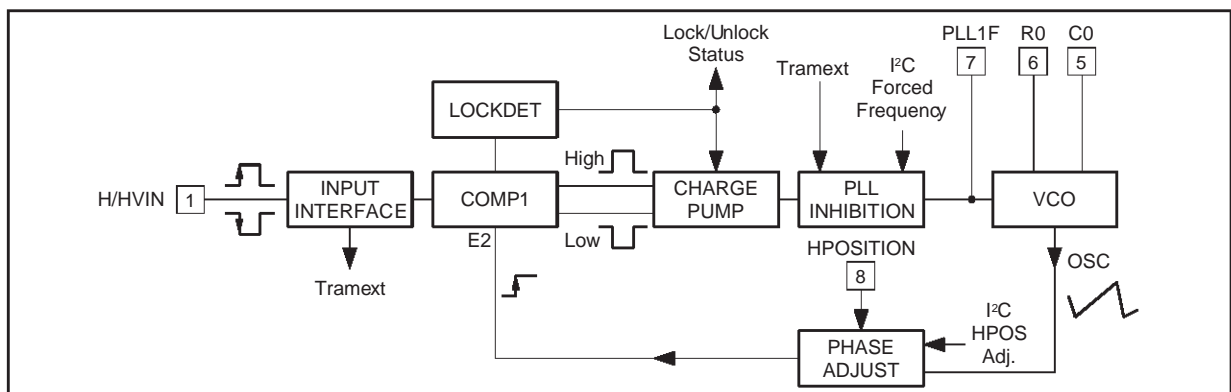
ure 8). The VCO uses an external RC network. It delivers a linear sawtooth obtained by the charge and the discharge of the capacitor, with a current proportional to the current in the resistor. The typical thresholds of the sawtooth are 1.6V and 6.4V. The control voltage of the VCO is between 1.33V and 6V (see Figure 9). The theoretical frequency range of this VCO is in the ratio of 1 to 4.5. The effective frequency range has to be smaller (1 to 4.2) due to clamp intervention on the filter lowest value.

**Figure 7**



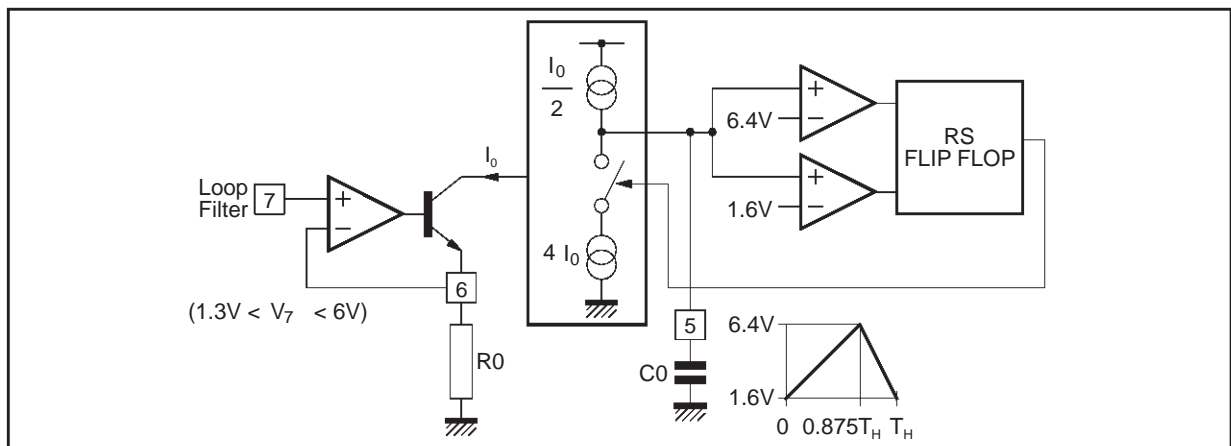
9109N-27.EPS

**Figure 8 : Block Diagram**



9109N-28.EPS

**Figure 9 : Details of VCO**



9109N-29.EPS

**OPERATING DESCRIPTION** (continued)

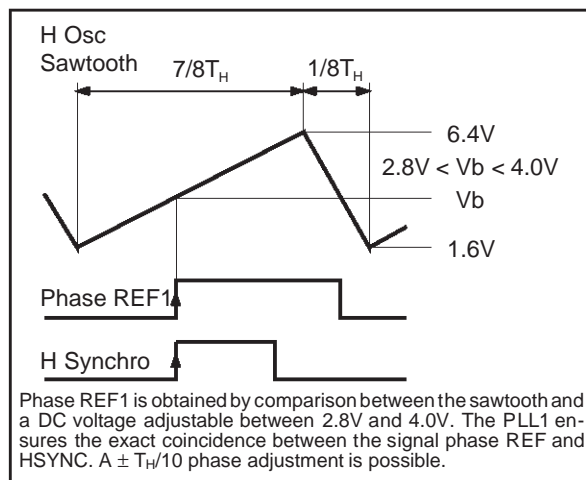
The sync frequency must always be higher than the free running frequency. For example, when using a sync range between 24kHz and 100kHz, the suggested free running frequency is 23kHz.

This can be obtained only by adjusting  $f_0$  (for instance, making  $R_0$  adjustable). If no adjustment is possible, more margin must be provided to cope with the components spread:  $\pm 8\%$  for the IC,  $\pm 1\%$  for  $R_0$ ,  $\pm 2$  or  $5\%$  for  $C_0$ , leading to  $\pm 11\%$  or  $14\%$  on  $f_0$ . The same percentage of frequency range will be lost at upper end of the range.

Another feature is the capability for the MCU to force the horizontal frequency through I<sup>2</sup>C to 2x $f_0$  or 3x $f_0$  (for burn-in mode or safety requirements). In this case, the inhibition switch is opened, leaving PLL1 free, but the voltage on PLL1 filter is forced to 2.66V (for 2x $f_0$ ) or 4.0V (for 3x $f_0$ ).

PLL1 ensures the coincidence between the leading edge of the sync signal and a phase reference obtained by comparison between the sawtooth of the VCO and an internal DC voltage which is I<sup>2</sup>C adjustable between 2.8V and 4.0V (corresponding to  $\pm 10\%$ ) (see Figure 10).

**Figure 10 : PLL1 Timing Diagram**



The TDA9109/N also includes a Lock/Unlock identification block which senses in real time whether PLL1 is locked or not on the incoming horizontal sync signal. The resulting information is available on HLOCKOUT (see Sync Processor).

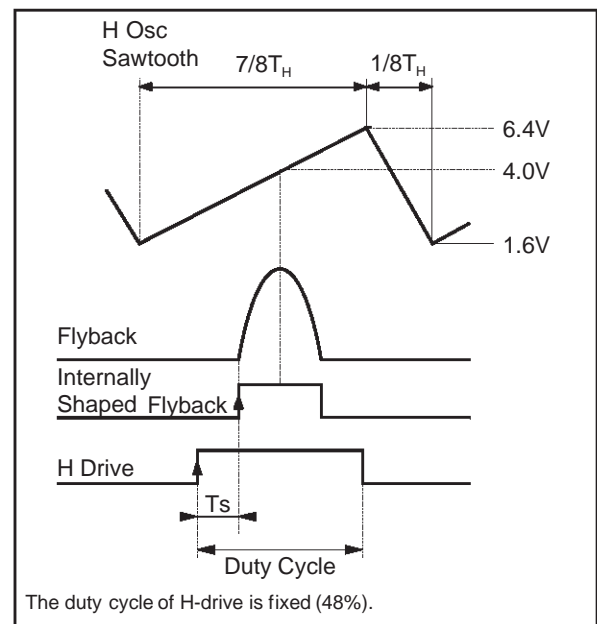
When PLL1 is unlocked, it forces HLOCKOUT to high level.

The lock/unlock information is also available through the I<sup>2</sup>C read.

**II.3 - PLL2**

PLL2 ensures a constant position of the shaped flyback signal in comparison with the sawtooth of the VCO, taking into account the saturation time  $T_s$  (see Figure 11).

**Figure 11 : PLL2 Timing Diagram**

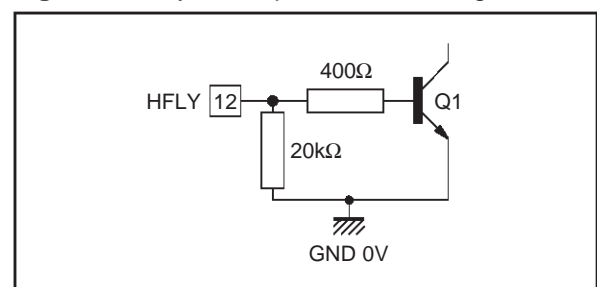


The phase comparator of PLL2 (phase type comparator) is followed by a charge pump (typical output current: 0.5mA).

The flyback input consists of an NPN transistor. This input must be current driven. The maximum recommended input current is 5mA (see Figure 12). The duty cycle is fixed (48%).

The maximum storage time ( $T_{s \text{ Max.}}$ ) is  $(0.44 T_H - T_{FLY}/2)$ . Typically,  $T_{FLY}/T_H$  is around 20% which means that  $T_s \text{ max}$  is around 34% of  $T_H$ .

**Figure 12 : Flyback Input Electrical Diagram**



**OPERATING DESCRIPTION** (continued)

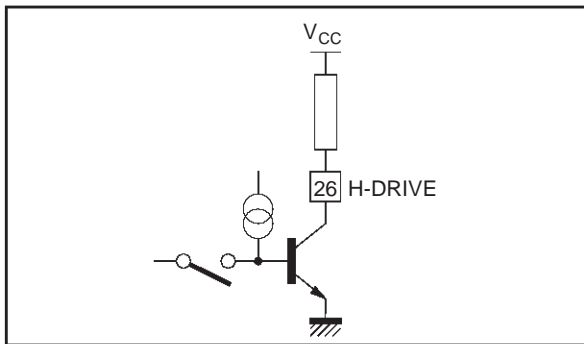
**II.4 - Output Section**

The H-drive signal is sent to the output through a shaping stage which also controls the H-drive duty cycle ( $I^2C$  adjustable) (see Figure 11). In order to secure the scanning power part operation, the output is inhibited in the following cases :

- when  $V_{CC}$  or  $V_{DD}$  are too low,
- when the XRAY protection is activated,
- during the Horizontal flyback,
- when the HDrive  $I^2C$  bit control is off.

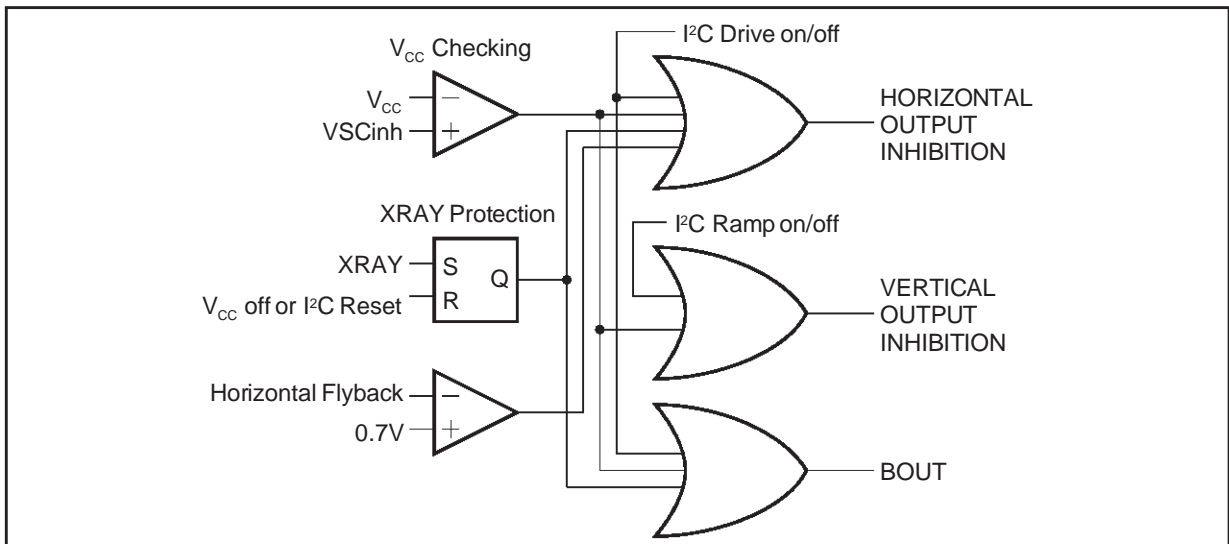
The output stage consists of a NPN bipolar transistor. Only the collector is accessible (see Figure 13).

**Figure 13**



This output stage is intended for "reverse" base control, where setting the output NPN in off-state will control the power scanning transistor in off-state (see Application Diagram).

**Figure 14 : Safety Functions Block Diagram**



The maximum output current is 30mA, and the corresponding voltage drop of the output  $V_{CEsat}$  is 0.4V Max.

Obviously the power scanning transistor cannot be directly driven by the integrated circuit. An interface has to be added between the circuit and the power transistor either of bipolar or MOS type.

**II.5 - X-RAY Protection**

The X-Ray protection is activated by application of a high level on the X-Ray input (8V on Pin 25).

It inhibits the H-Drive and B+ outputs.

This protection is latched ; it may be reset either by  $V_{CC}$  switch off or by  $I^2C$  (see Figure 14).

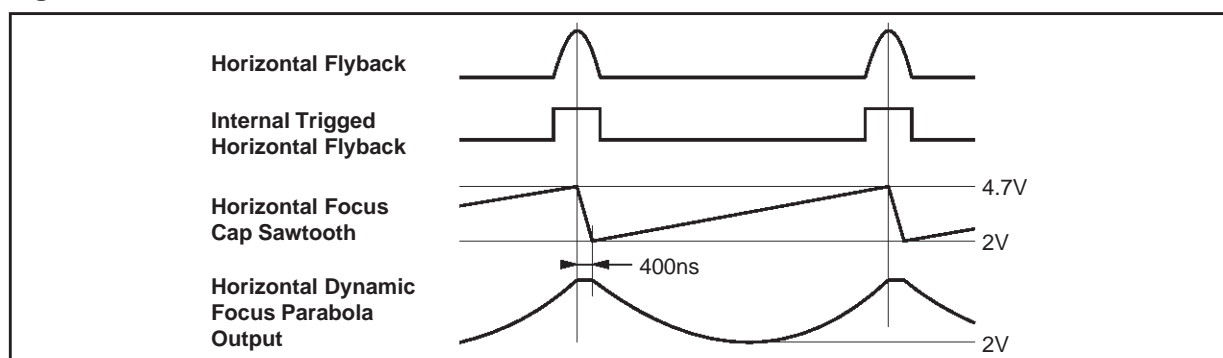
**II.6 - Horizontal and Vertical Dynamic Focus**

The TDA9109/N delivers a horizontal parabola which is added on a vertical parabola waveform on Pin 10. This horizontal parabola comes from a sawtooth in phase with flyback pulse middle. This sawtooth is present on Pin 9 where the horizontal focus capacitor should be the same as C0 to obtain the correct amplitude (from 2 to 4.7V typically).

Symmetry and amplitude are  $I^2C$  adjustable (see Figure 15). The vertical dynamic focus is tracked with VPOS and VAMP. Its amplitude can be adjusted. It is also affected by S and C corrections. This positive signal once amplified is to be sent to the CRT focusing grids.

## OPERATING DESCRIPTION (continued)

Figure 15



9109N-35:EPS

## III - VERTICAL PART

## III.1 - Function

When the synchronization pulse is not present, an internal current source sets the free running frequency. For an external capacitor,  $C_{OSC} = 150\text{nF}$ , the typical free running frequency is 100Hz.

The typical free running frequency can be calculated by :

$$f_0 \text{ (Hz)} = 1.5 \cdot 10^{-5} \cdot \frac{1}{C_{OSC}}$$

A negative or positive TTL level pulse applied on Pin2 (VSYNC) as well as a TTL composite sync on Pin 1 can synchronize the ramp in the range  $[f_{min}, f_{max}]$ . This frequency range depends on the external capacitor connected on Pin 22. A 150nF ( $\pm 5\%$ ) capacitor is recommended for 50Hz to 165Hz applications.

The typical maximum and minimum frequency, at 25°C and without any correction (S correction or C correction), can be calculated by :

$$f_{(Max.)} = 2.5 \times f_0 \text{ and } f_{(Min.)} = 0.33 \times f_0$$

If S or C corrections are applied, these values are slightly affected.

If a synchronization pulse is applied, the internal oscillator is synchronized immediately but its amplitude changes. An internal correction then adjusts it in less than half a second. The top value of the ramp (Pin 22) is sampled on the AGC capacitor (Pin 20) at each clock pulse and a transconductance amplifier modifies the charge current of the capacitor in such a way to make the amplitude again constant.

The read status register provides the vertical Lock/Unlock and the vertical sync polarity information.

We recommend the use of an AGC capacitor with low leakage current. A value lower than 100nA is mandatory.

A good stability of the internal closed loop is reached by a  $470\text{nF} \pm 5\%$  capacitor value on Pin 20 (VAGC).

III.2 - I<sup>2</sup>C Control Adjustments

S and C correction shapes can then be added to this ramp. These frequency independent S and C corrections are generated internally. Their amplitudes are adjustable by their respective I<sup>2</sup>C registers. They can also be inhibited by their select bits.

Finally, the amplitude of this S and C corrected ramp can be adjusted by the vertical ramp amplitude control register.

The adjusted ramp is available on Pin 23 (V<sub>OUT</sub>) to drive an external power stage.

The gain of this stage can be adjusted ( $\pm 25\%$ ) depending on its register value.

The mean value of this ramp is driven by its own I<sup>2</sup>C register (vertical position). Its value is  $V_{POS} = 7/16 \cdot V_{REF-V} \pm 300\text{mV}$ .

Usually V<sub>OUT</sub> is sent through a resistive divider to the inverting input of the booster. Since V<sub>POS</sub> derives from V<sub>REF-V</sub>, the bias voltage sent to the non-inverting input of the booster should also derive from V<sub>REF-V</sub> to optimize the accuracy (see Application Diagram).

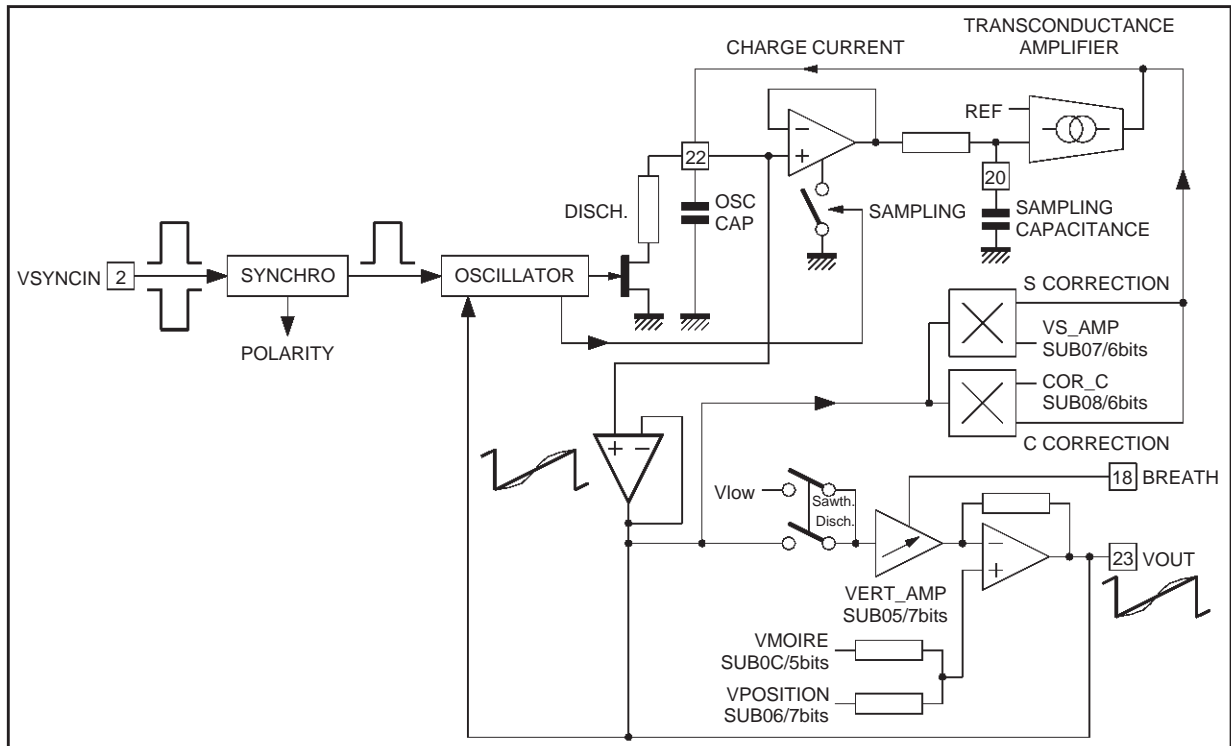
## III.3 - Vertical Moiré

By using the vertical moiré, V<sub>POS</sub> can be modulated from frame to frame. This function is intended to cancel the fringes which appear when line to line interval is very close to the CRT vertical pitch.

The amplitude of the modulation is controlled by register VMOIRE on sub-address 0C and can be switched-off via the control bit D7.

## OPERATING DESCRIPTION (continued)

Figure 16 : AGC Loop Block Diagram



### III.4 - Basic Equations

In first approximation, the amplitude of the ramp on Pin 23 (VOUT) is :

$$V_{OUT} - V_{POS} = (V_{OSC} - V_{DCMID}) \cdot (1 + 0.25 (V_{AMP}))$$

with :

- $V_{DCMID} = 7/16 \cdot V_{REF}$  (middle value of the ramp on Pin 22, typically 3.5V)
- $V_{OSC} = V_{22}$  (ramp with fixed amplitude)
- $V_{AMP} = -1$  for minimum vertical amplitude register value and +1 for maximum
- $V_{POS}$  is calculated by :  $V_{POS} = V_{DCMID} + 0.3 V_P$  with  $V_P$  equals -1 for minimum vertical position register value and +1 for maximum

The current available on Pin 22 is :

$$I_{OSC} = \frac{3}{8} \cdot V_{REF} \cdot C_{OSC} \cdot f$$

with :  $C_{OSC}$  : capacitor connected on Pin 22 and  $f$  : synchronization frequency.

### III.5 - Geometric Corrections

The principle is represented in Figure 17.

Starting from the vertical ramp, a parabola-shaped current is generated for E/W correction (also known as Pin Cushion correction), dynamic horizontal

phase control correction, and vertical dynamic Focus correction.

The parabola generator is made by an analog multiplier, the output current of which is equal to :

$$DI = k \cdot (V_{OUT} - V_{DCMID})^2$$

where  $V_{OUT}$  is the vertical output ramp (typically between 2 and 5V) and  $V_{DCMID}$  is 3.5V (for  $V_{REF-V} = 8V$ ).

The VOUT sawtooth is typically centered on 3.5V. By changing the vertical position, the sawtooth shifts by  $\pm 0.3V$ .

In order to have good screen geometry for any end user adjustment, the TDA9109/N has the "geometry tracking" feature, which allows generation of a dissymmetric parabola depending on the vertical position.

Due to the large output stage voltage range (E/W, Keystone), the combination of tracking function with maximum vertical amplitude, maximum or minimum vertical position and maximum gain on the DAC control may lead to the output stage saturation. This must be avoided by limiting the output voltage with appropriate  $I^2C$  registers values.

**OPERATING DESCRIPTION** (continued)

For the E/W part and the dynamic horizontal phase control part, a sawtooth-shaped differential current in the following form is generated :

$$DI' = k' \cdot (V_{OUT} - V_{DCMID})$$

Then  $\Delta I$  and  $\Delta I'$  are added and converted into voltage for the E/W part.

Each of the two E/W components or the two dynamic horizontal phase control ones may be inhibited by their own I<sup>2</sup>C select bit.

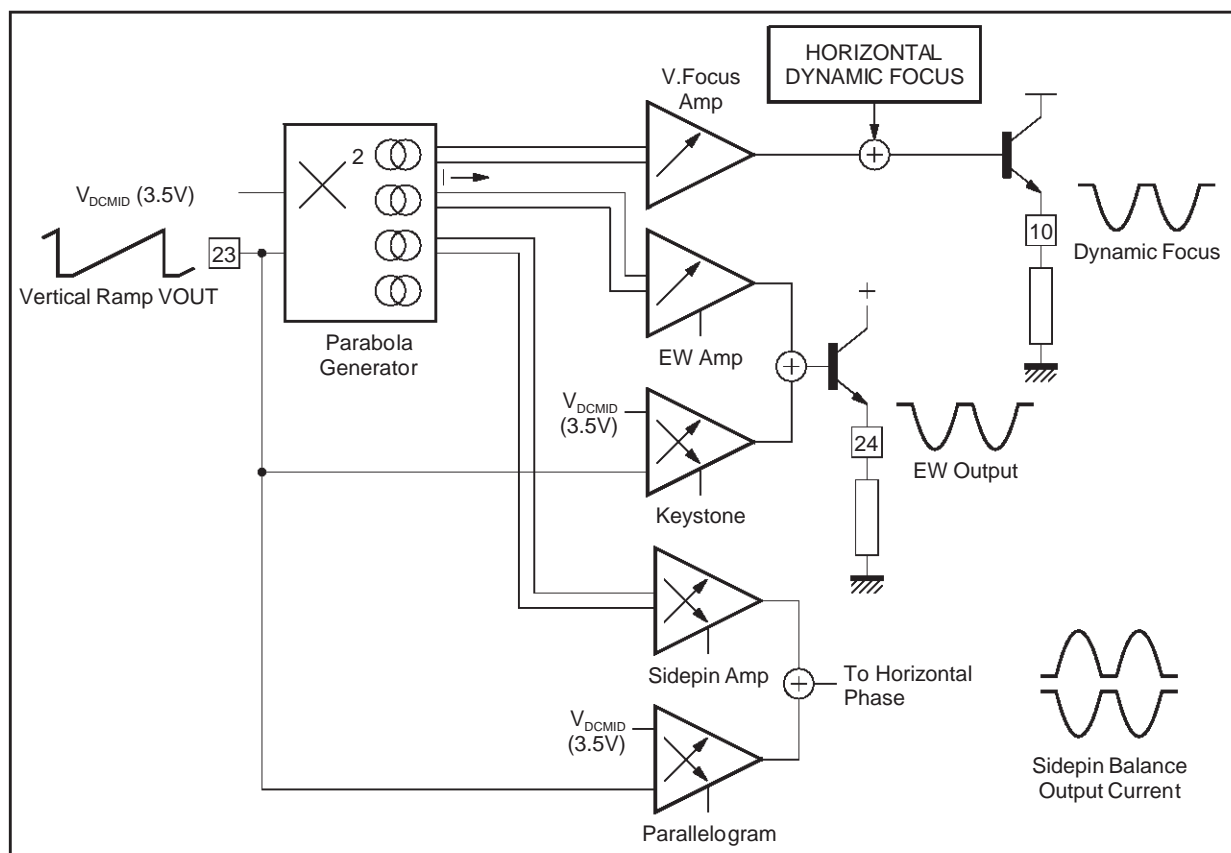
The E/W parabola is available on Pin 24 via an

emitter follower output stage which has to be biased by an external resistor (10k $\Omega$  to ground). Since stable in temperature, the device can be DC coupled with an external circuitry.

The vertical dynamic focus is combined with the horizontal focus on Pin 10.

The dynamic horizontal phase control drives internally the H-position, moving the HFLY position on the horizontal sawtooth in the range of  $\pm 1.4\%$  T<sub>H</sub> both for side pin balance and parallelogram.

**Figure 17** : Geometric Corrections Principle

**III.6 - E/W**

$$EWOUT = 2.5V + K1 (V_{OUT} - V_{DCMID}) + K2 (V_{OUT} - V_{DCMID})^2$$

K1 is adjustable by the keystone I<sup>2</sup>C register

K2 is adjustable by the E/W amplitude I<sup>2</sup>C register

**III.7 - Dynamic Horizontal Phase Control**

$$I_{OUT} = K3 (V_{OUT} - V_{DCMID}) + K4 (V_{OUT} - V_{DCMID})^2$$

K3 is adjustable by the parallelogram I<sup>2</sup>C register

K4 is adjustable by the side pin balance I<sup>2</sup>C register



**OPERATING DESCRIPTION** (continued)

**IV - DC/DC CONVERTER PART**

This unit controls the switch-mode DC/DC converter. It converts a DC constant voltage into the B+ voltage (roughly proportional to the horizontal frequency) necessary for the horizontal scanning. This DC/DC converter can be configured either in step-up or step-down mode. In both cases it operates very similarly to the well known UC3842.

**IV.1 - Step-up Mode**

**Operating Description**

- The power MOS is switched-on during the flyback (at the beginning of the positive slope of the horizontal focus sawtooth).
- The power MOS is switched-off when its current reaches a predetermined value. For this purpose, a sense resistor is inserted in its source. The voltage on this resistor is sent to Pin16 (I<sub>SENSE</sub>).
- The feedback (coming either from the EHV or from the flyback) is divided to a voltage close to 4.8V and compared to the internal 4.8V reference (I<sub>VREF</sub>). The difference is amplified by an error amplifier, the output of which controls the power MOS switch-off current.

**Main Features**

- Switching synchronized on the horizontal frequency,
- B+ voltage always higher than the DC source,
- Current limited on a pulse-by-pulse basis.

**IV.2 - Step-down Mode**

In step-down mode, the I<sub>sense</sub> information is not used any more and therefore not sent to the Pin16. This mode is selected by connecting this Pin16 to a DC voltage higher than 6V (for example V<sub>REF-V</sub>).

**Operating Description**

- The power MOS is switched-on as for the step-up mode.
- The feedback to the error amplifier is done as for the step-up mode.
- The power MOS is switched-off when the HFOCUSCAP voltage get higher than the error amplifier output voltage.

**Main Features**

- Switching synchronized on the horizontal frequency,
- B+ voltage always lower than the DC source,
- No current limitation.

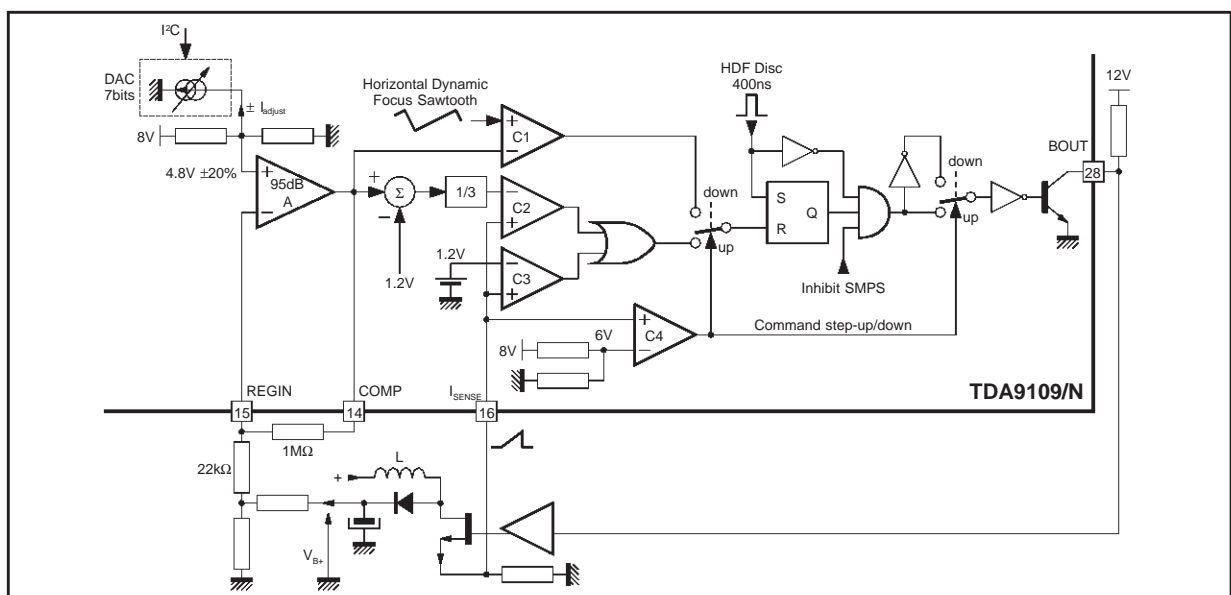
**IV.3- Step-up and Step-down Mode Comparison**

In step-down mode the control signal is inverted compared with the step-up mode.

The reason for this is the following :

- In step-up mode, the switch is a N-channel MOS referenced to ground and made conductive by a high level on its gate.
- In step-down, a high-side switch is necessary. It can be either a P- or a N-channel MOS.
- For a P-channel MOS, the gate is controlled directly from Pin28 through a capacitor (this allows to spare a Transformer). In this case, a negative-going pulse is needed to make the MOS conductive. Therefore it is necessary to invert the control signal.
- For a N-channel MOS, a transformer is needed to control the gate. The polarity of the transformer can be easily adapted to the negative-going control pulse.

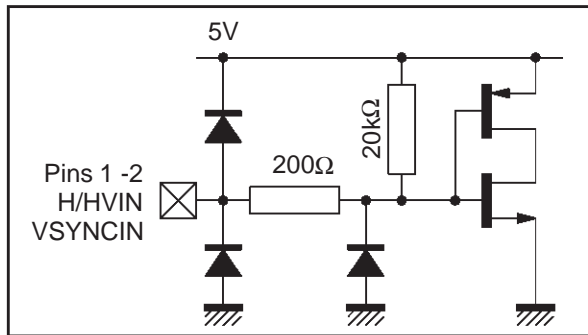
**Figure 18 : DC/DC Converter**





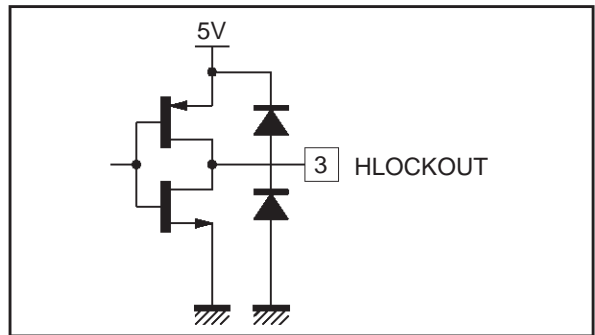
INTERNAL SCHEMATICS

Figure 19



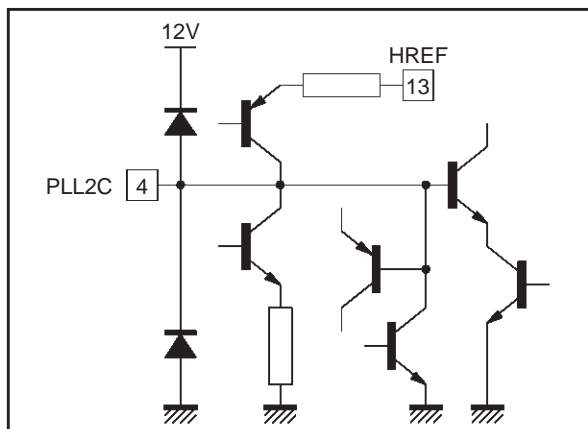
9109N-38.EPS

Figure 20



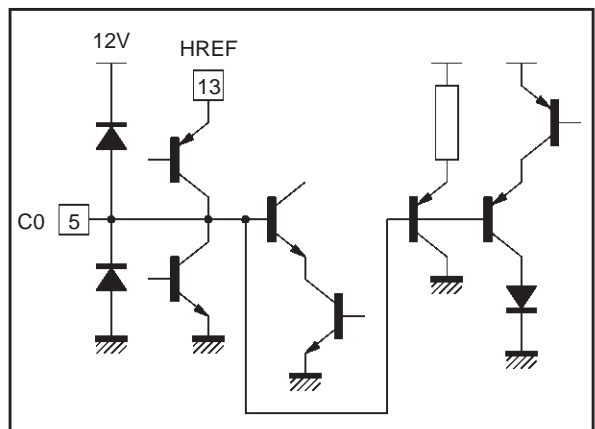
9109N-40.EPS

Figure 21



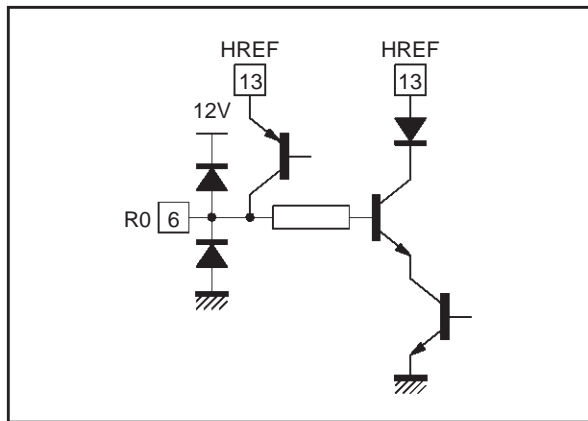
9109N-41.EPS

Figure 22



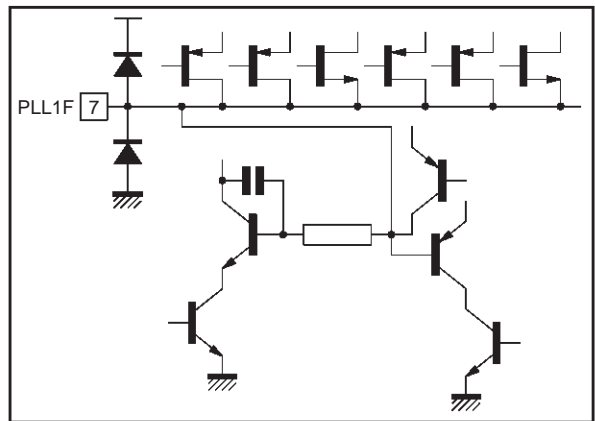
9109N-42.EPS

Figure 23



9109N-43.EPS

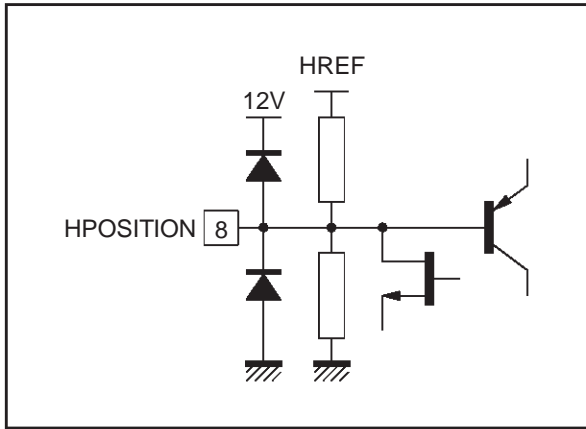
Figure 24



9109N-44.EPS

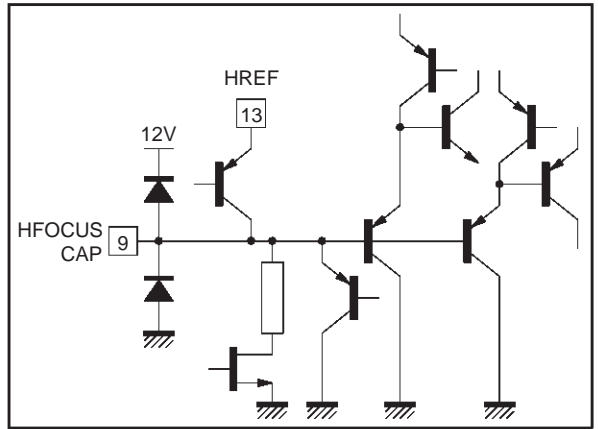
INTERNAL SCHEMATICS (continued)

Figure 25



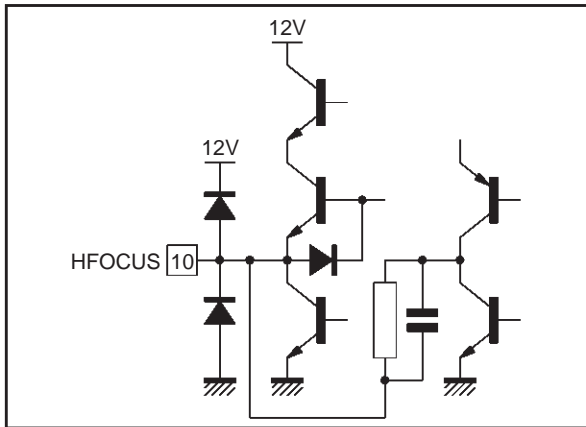
9109N-45.EPS

Figure 26



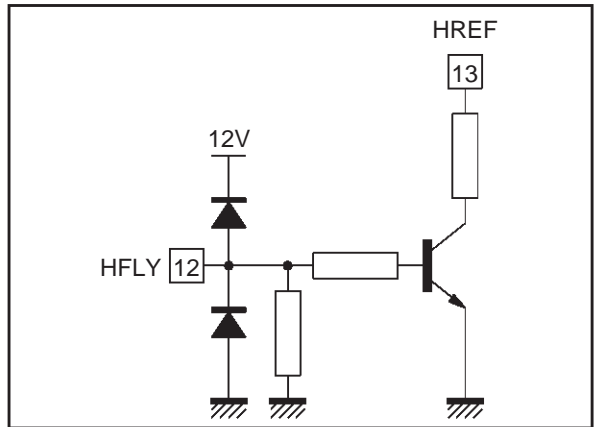
9109N-46.EPS

Figure 27



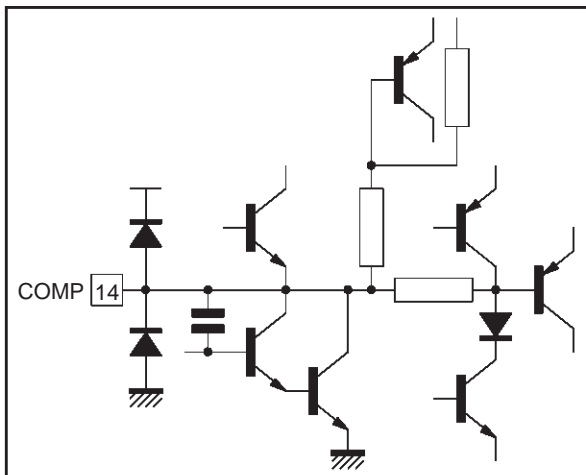
9109N-47.EPS

Figure 28



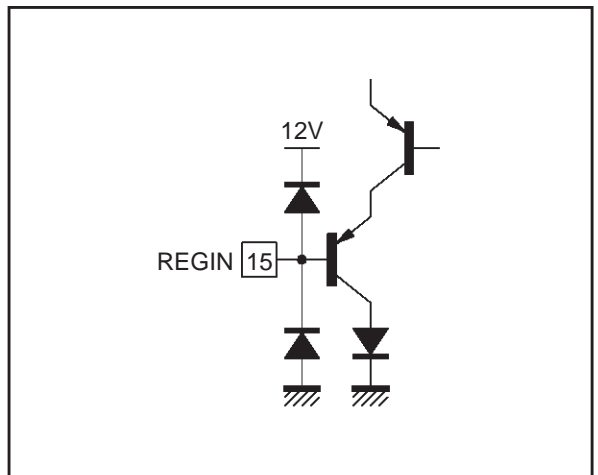
9109N-48.EPS

Figure 29



9109N-49.EPS

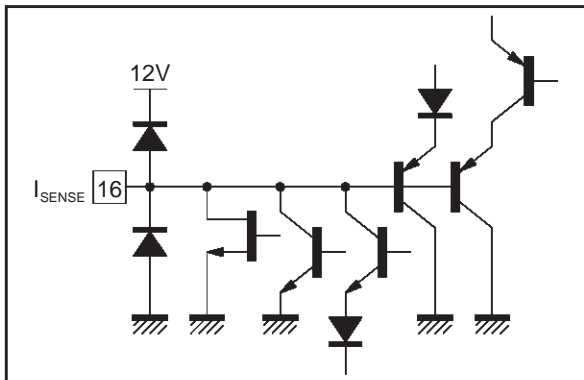
Figure 30



9109N-50.EPS

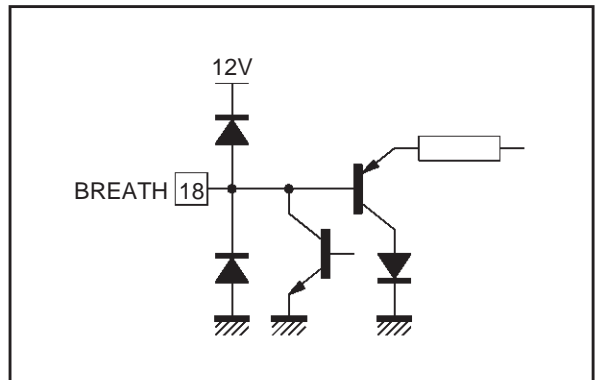
INTERNAL SCHEMATICS (continued)

Figure 31



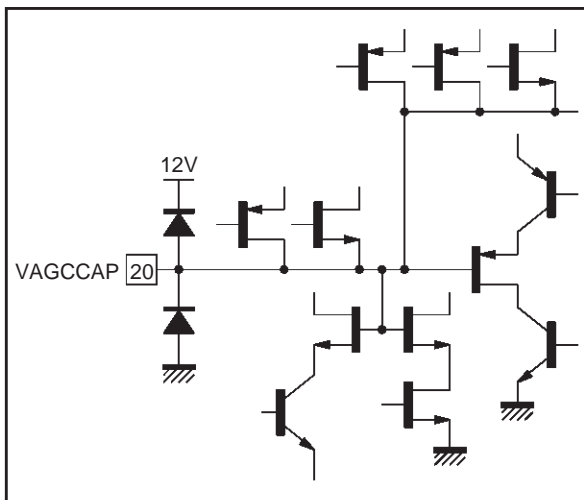
9109N-51.EPS

Figure 32



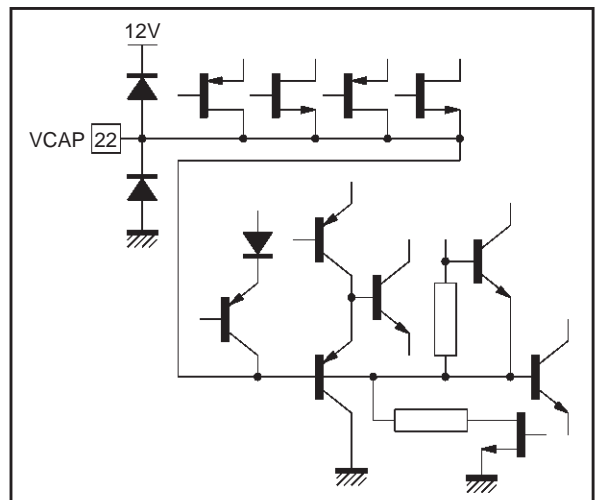
9109N-52.EPS

Figure 33



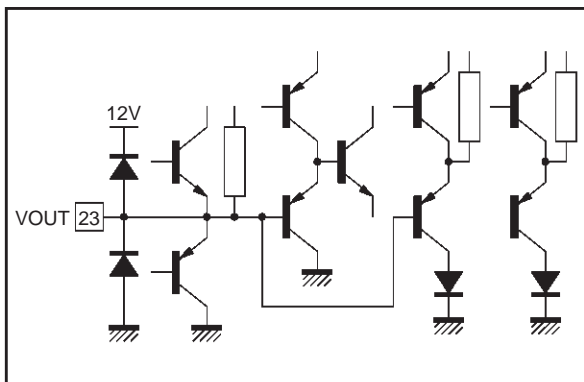
9109N-53.EPS

Figure 34



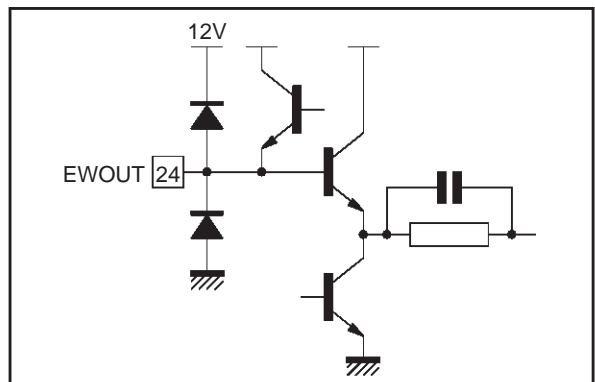
9109N-54.EPS

Figure 35



9109N-55.EPS

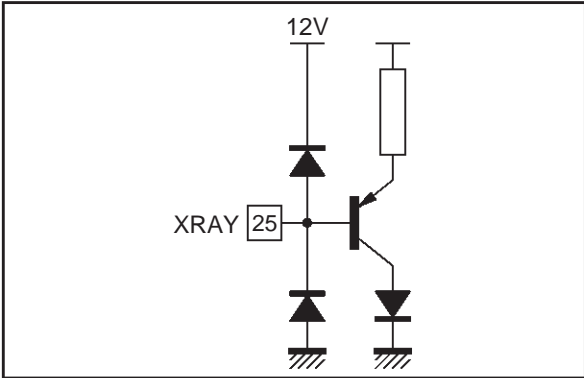
Figure 36



9109N-56.EPS

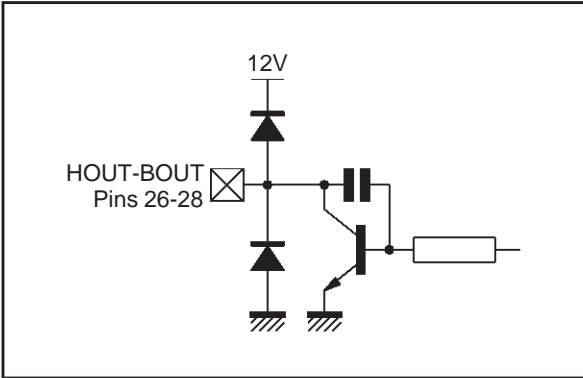
INTERNAL SCHEMATICS (continued)

Figure 37



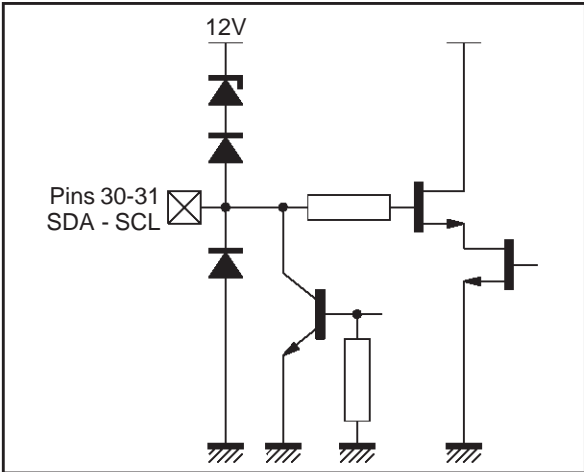
9109N-57.EPS

Figure 38



9109N-58.EPS

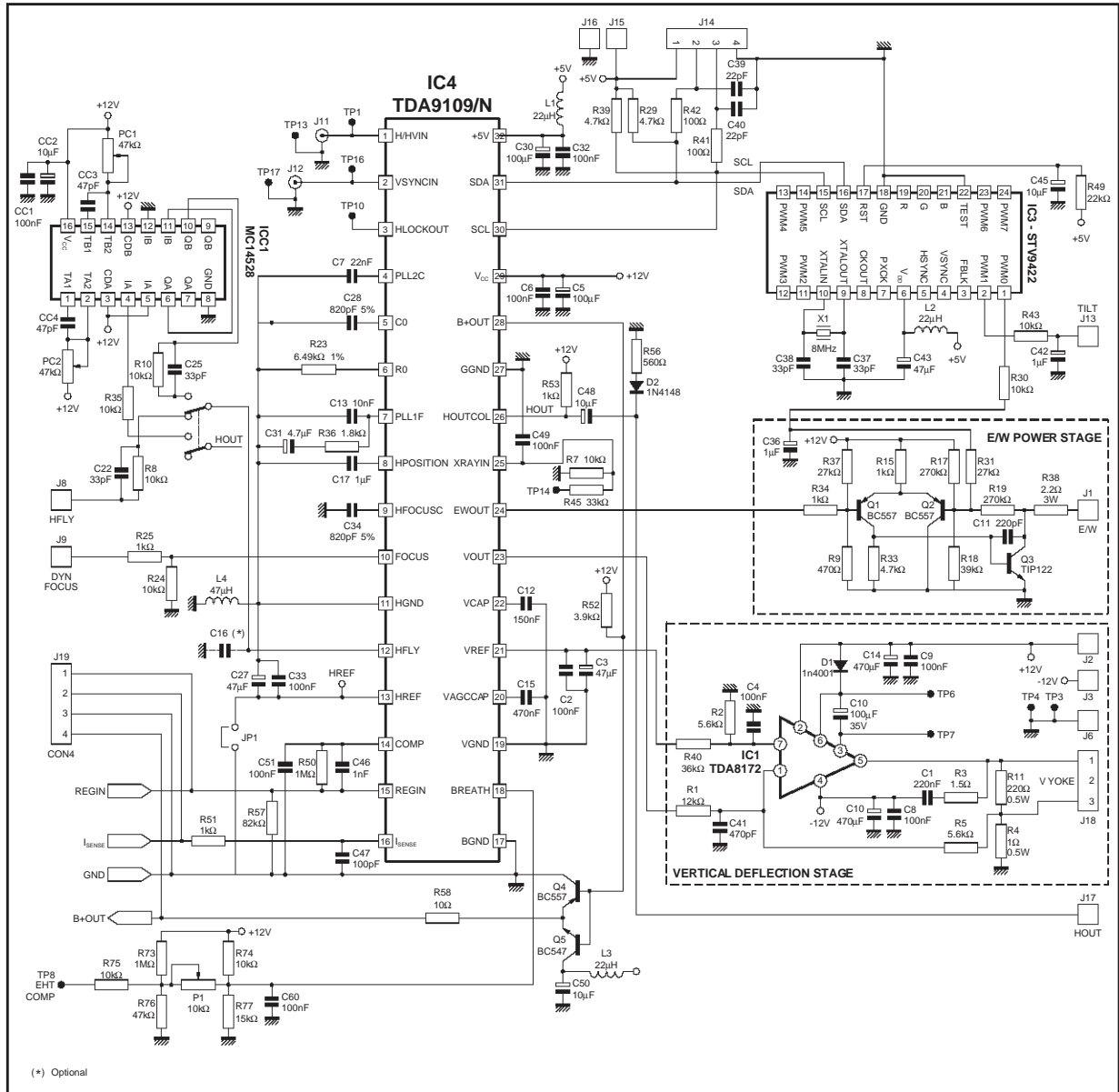
Figure 39



9109N-59.EPS

APPLICATION DIAGRAMS

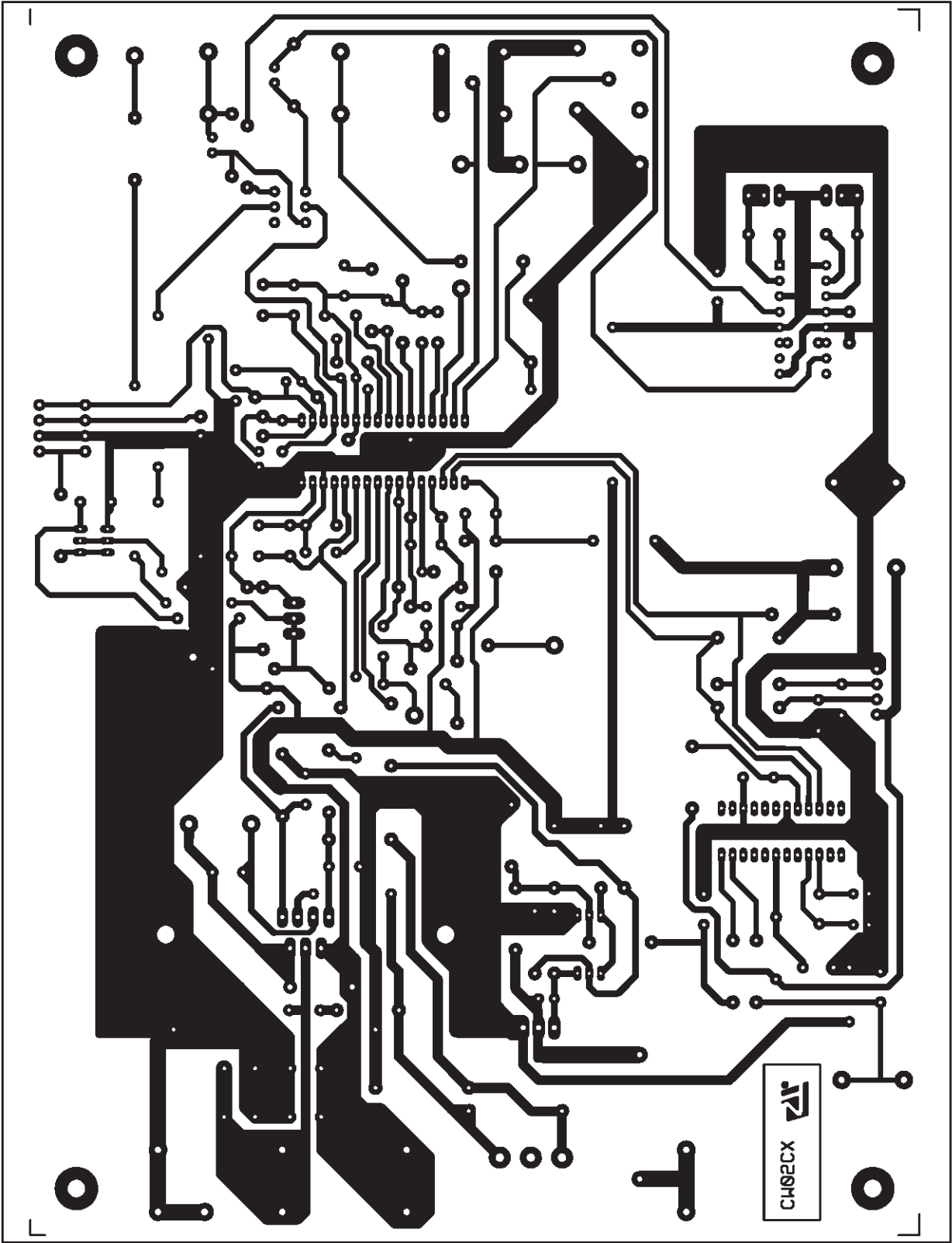
Figure 40 : Demonstration Board



9109N-60.EPS

APPLICATION DIAGRAMS (continued)

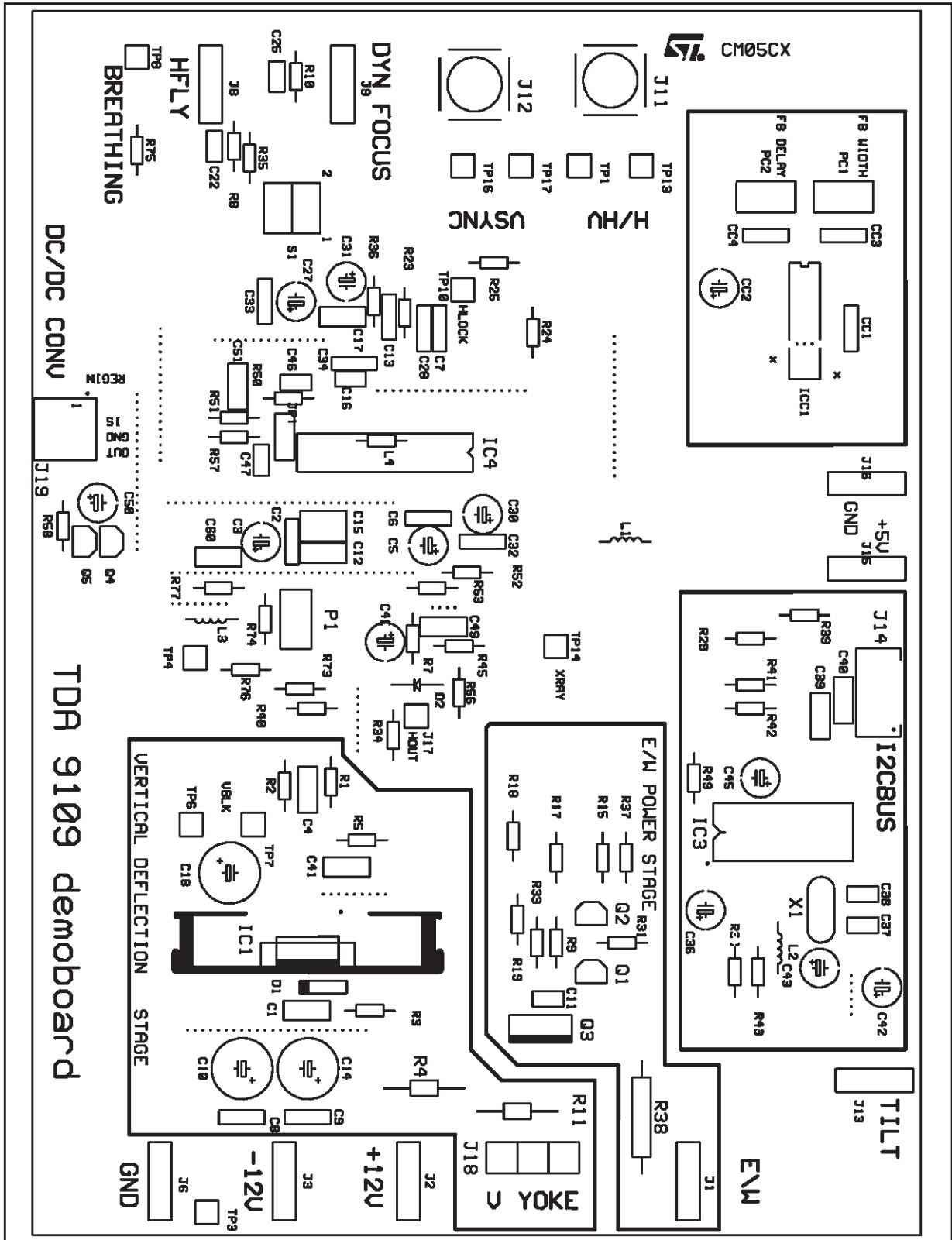
Figure 41 : PCB Layout



9109N461.EPS

APPLICATION DIAGRAMS (continued)

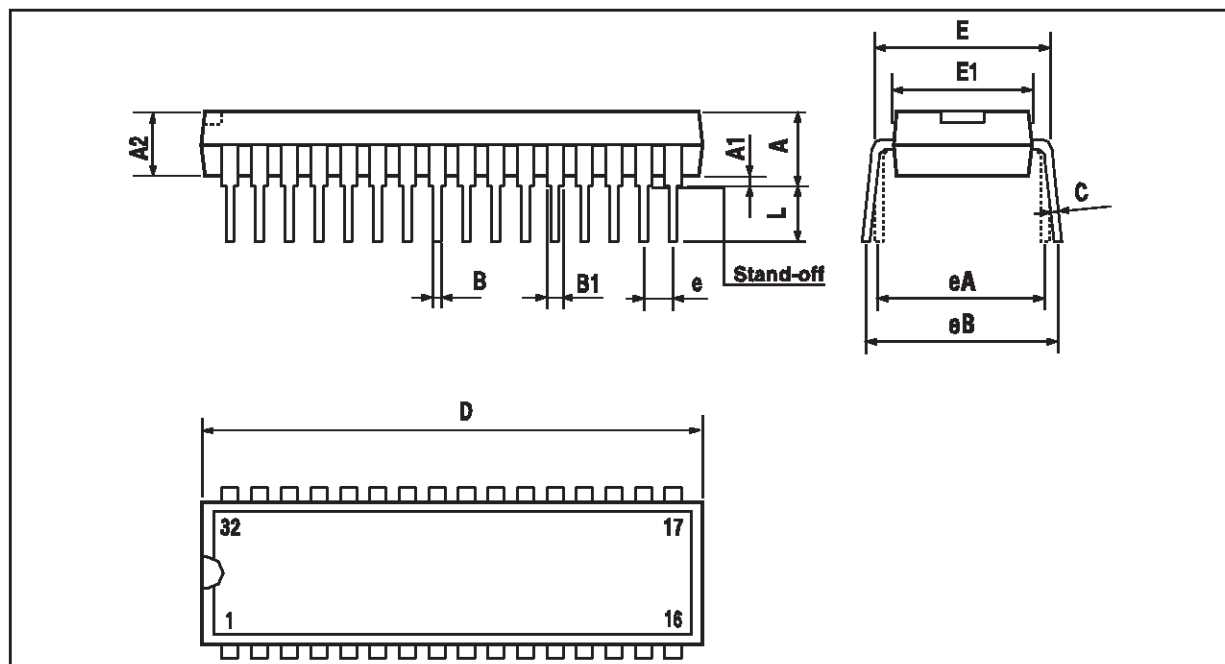
Figure 42 : Components Layout



9109N16016



**PACKAGE MECHANICAL DATA**  
32 PINS - PLASTIC SHRINK DIP



PMSDIP32.EPS

| Dimensions | Millimeters |       |       | Inches |       |       |
|------------|-------------|-------|-------|--------|-------|-------|
|            | Min.        | Typ.  | Max.  | Min.   | Typ.  | Max.  |
| A          | 3.556       | 3.759 | 5.080 | 0.140  | 0.148 | 0.200 |
| A1         | 0.508       |       |       | 0.020  |       |       |
| A2         | 3.048       | 3.556 | 4.572 | 0.120  | 0.140 | 0.180 |
| B          | 0.356       | 0.457 | 0.584 | 0.014  | 0.018 | 0.023 |
| B1         | 0.762       | 1.016 | 1.397 | 0.030  | 0.040 | 0.055 |
| C          | 0.203       | 0.254 | 0.356 | 0.008  | 0.010 | 0.014 |
| D          | 27.43       | 27.94 | 28.45 | 1.080  | 1.100 | 1.120 |
| E          | 9.906       | 10.41 | 11.05 | 0.390  | 0.410 | 0.435 |
| E1         | 7.620       | 8.890 | 9.398 | 0.300  | 0.350 | 0.370 |
| e          |             | 1.778 |       |        | 0.070 |       |
| eA         |             | 10.16 |       |        | 0.400 |       |
| eB         |             |       | 12.70 |        |       | 0.500 |
| L          | 2.540       | 3.048 | 3.810 | 0.100  | 0.120 | 0.150 |

SDIP32.TBL

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