STV6889

HIGH-END I²C CONTROLLED DEFLECTION PROCESSOR FOR MULTISYNC MONITOR

PRODUCT PREVIEW

FEATURES

General

- Advanced I^2C-bus controlled deflection processor dedicated for high-end CRT monitors
- Single supply voltage 12V
- Very low jitter
- DC/DC converter controller
- Advanced EW drive
- Advanced asymmetry corrections
- Automatic multistandard synchronization
- Vertical dynamic correction waveform output
- X-ray protection and Soft-start & stop on horizontal and DC/DC drive outputs
- I^2C-bus status register

Horizontal section

- 150 kHz maximum frequency
- Corrections of geometric asymmetry: Pin cushion asymmetry, Parallelogram, separate Top/Bottom corner asymmetry
- Tracking of asymmetry corrections with vertical size and position
- Fully integrated horizontal moiré cancellation

Vertical section

- 200 Hz maximum frequency
- Vertical ramp for DC-coupled output stage with adjustments of: C-correction, S-correction for super-flat CRT, Vertical size, Vertical position
- Vertical size and position prescales for factory adjustment
- Vertical moiré cancellation through vertical ramp waveform
- Compensation of vertical breathing with EHT variation; I^2C-bus gain adjustment

EW section

- Symmetrical geometry corrections: Pin cushion, Keystone, Top/Bottom corners separately, S- and W-corrections
- Horizontal size adjustment
- Tracking of EW waveform with Vertical size and position, horizontal size and frequency
- Compensation of horizontal breathing with EHT variation, I^2C-bus gain adjustment

Dynamic correction section

- Generates vertical waveform for dynamic corrections like focus, brightness uniformity, ...
- 1 output with vertical dynamic correction waveform, both polarities, tracking with vertical size and position

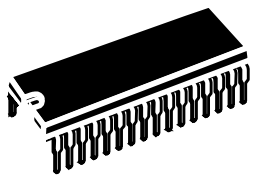
DC/DC controller section

- Step-up and step-down conversion modes
- External sawtooth configuration
- I^2C-bus-controlled output voltage
- Synchronized on hor. frequency with phase selection
- Selectable polarity of drive signal
- Protection at H unlock condition

DESCRIPTION

The STV6889 is a monolithic integrated circuit assembled in a 32-pin shrink dual-in-line plastic package. This IC controls all the functions related to horizontal and vertical deflection in multimode or multi-frequency computer display monitors.

Combined with other ST components dedicated for CRT monitors (microcontroller, video preamplifier, video amplifier, OSD controller), the STV6889 allows fully I^2C bus-controlled computer display monitors to be built with a reduced number of external components.



SDIP 32 (Shrink DIP package)
ORDER CODE: STV6889

Version 1.1

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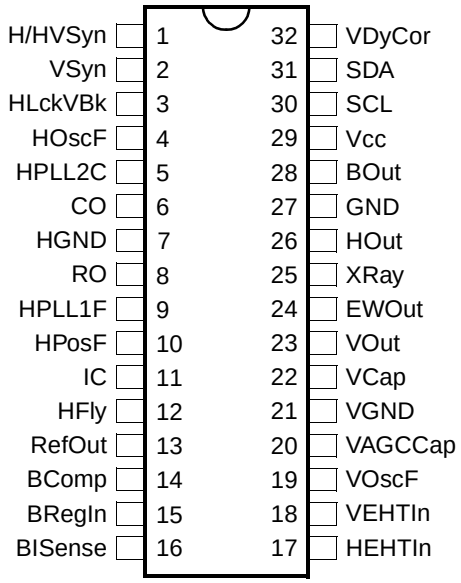
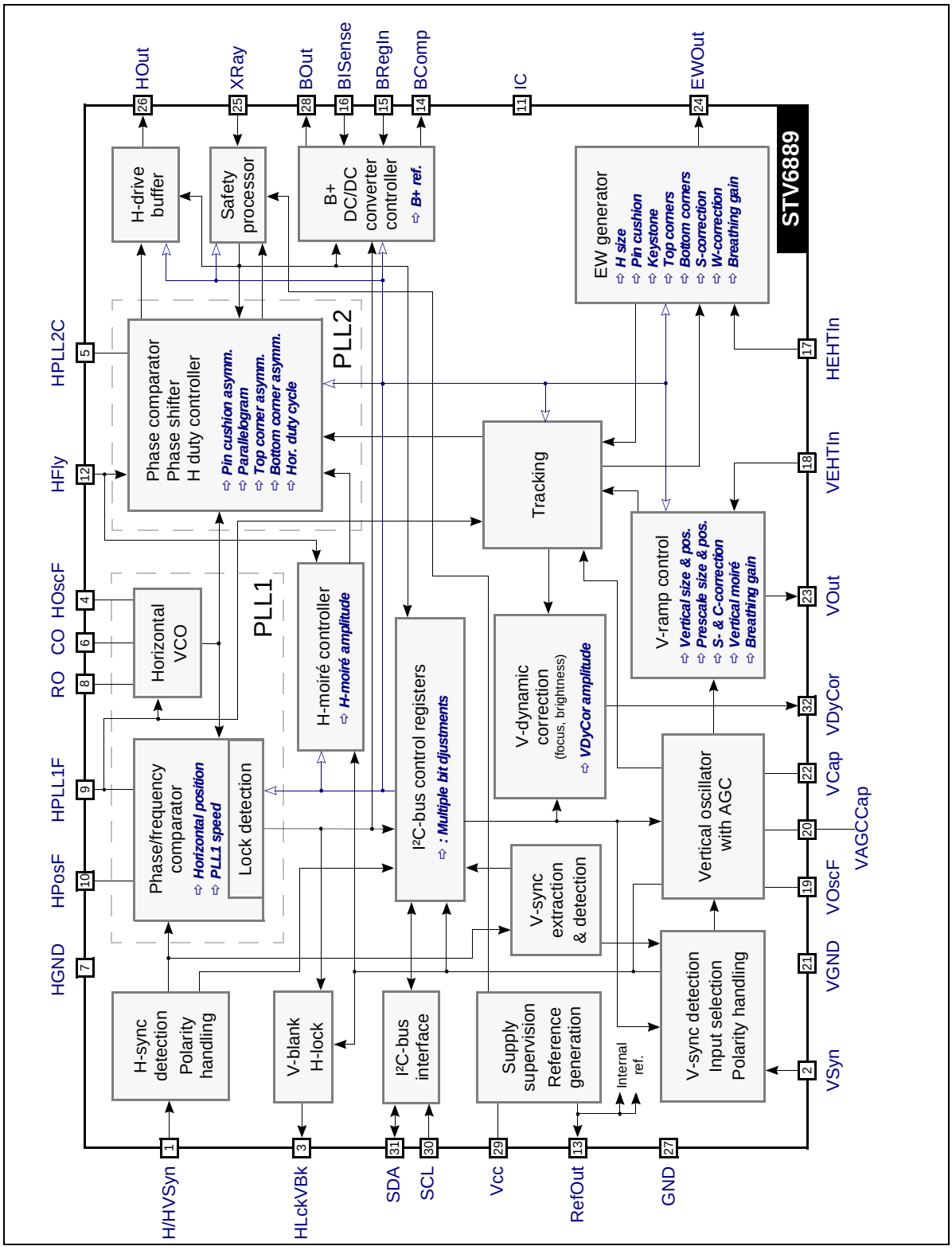
1 PIN CONFIGURATION



2 BLOCK DIAGRAM



3 PIN FUNCTION REFERENCE

Pin	Name	Function
1	H/HVSyn	TTL compatible **H**orizontal **/ H**orizontal and **V**ertical **Syn**c. input
2	VSyn	TTL compatible **V**ertical **Syn**c. input
3	HLckVBk	**H**orizontal PLL1 **Lo**c**k** detection and **V**ertical early **B**lan**k**ing composite output
4	HOscF	High **H**orizontal **Osc**illator sawtooth threshold level **F**ilter input
5	HPLL2C	**H**orizontal **PLL2** loop **C**apacitive filter input
6	CO	Horizontal **O**scillator **C**apacitor input
7	HGND	**H**orizontal section **G**rou**ND**
8	RO	Horizontal **O**scillator **R**esistor input
9	HPLL1F	**H**orizontal **PLL1** loop **F**ilter input
10	HPosF	**H**orizontal **Pos**ition **F**ilter and soft-start time constant capacitor input
11	IC	**I**nternally **C**onnected (to be left open)
12	HFly	**H**orizontal **Fly**back input
13	RefOut	**Ref**erence voltage **Out**put
14	BComp	**B**+ DC/DC error amplifier (**Comp**ensation) output
15	BRegIn	**Reg**ulation feedback **In**put of the **B**+ DC/DC converter controller
16	BISense	**B**+ DC/DC converter current (**I**) **Sense** input
17	HEHTIn	**In**put for compensation of **H**orizontal amplitude versus **EHT** variation
18	VEHTIn	**In**put for compensation of **V**ertical amplitude versus **EHT** variation
19	VOscF	**V**ertical **Osc**illator sawtooth low threshold **F**ilter (capacitor to be connected to VGND)
20	VAGCCap	Input for storage **Cap**acitor for **A**utomatic **G**ain **C**ontrol loop in **V**ertical oscillator
21	VGND	**V**ertical section **G**rou**ND**
22	VCap	**V**ertical sawtooth generator **Cap**acitor
23	VOut	**V**ertical deflection drive **Out**put for a DC-coupled output stage
24	EWOut	**E/W Out**put
25	XRay	**X-Ray** protection input
26	HOut	**H**orizontal drive **Out**put
27	GND	Main **G**rou**ND**
28	BOut	**B**+ DC/DC converter controller **Out**put
29	Vcc	Supply voltage
30	SCL	I²C-bus **S**erial **CL**ock Input
31	SDA	I²C-bus **S**erial **DA**ta input/output
32	VDyCor	**V**ertical **Dy**namic **Cor**rection output

4 QUICK REFERENCE DATA

Characteristic	Value	Unit
General		
Package	SDIP 32	
Supply voltage	12	V
Supply current	65	mA
Application category	High-end	
Means of control • Maximum clock frequency	I²C-bus • 400	kHz
EW drive	Yes	
DC/DC converter controller	Yes	
Horizontal section		
Frequency range	15 to 150	kHz
Autosync frequency ratio (can be enlarged in application)	4.28	
Positive • Negative polarity of horizontal sync signal • Automatic adaptation	Yes • Yes • Yes	
Duty cycle range of the drive signal	30 to 65	%
Position adjustment range with respect to H period	±10	%
Soft start • Soft stop feature	Yes • Yes	
Hardware • Software PLL lock indication	Yes • Yes	
Parallelogram	Yes	
Pin cushion asymmetry correction (also called Side pin balance)	Yes	
Top • Bottom • Common corner asymmetry correction	Yes • Yes • No	
Tracking of asymmetry corrections with vertical size & position	Yes	
Horizontal moiré cancellation (int.) for Combined • Separated architecture	Yes • Yes	
Vertical section		
Frequency range	35 to 200	Hz
Autosync frequency range (150nF at VCap and 470nF at VAGCCap)	50 to 180	Hz
Positive • Negative polarity of vertical sync signal • Automatic adaptation	Yes • Yes • Yes	
S-correction • C-correction • Super-flat tube characteristic	Yes • Yes • Yes	
Vertical size • Vertical position • Prescale adjustments	Yes • Yes • Yes	
Vertical moiré cancellation (internal)	Yes	
EHT breathing compensation • With I²C-bus gain control	Yes • Yes	
EW section		
Pin cushion correction	Yes	
Keystone correction	Yes	
Top • Bottom • Common corner correction	Yes • Yes • No	
S-correction • W-correction	Yes • Yes	
Horizontal size adjustment	Yes	
Tracking of EW waveform with Frequency • Vertical size & position	Yes • Yes	
EHT breathing compensation • With I²C-bus gain control	Yes • Yes	
Dynamic correction section (dyn. focus, dyn. brightness,...)		
Vertical dynamic correction output VDyCor • Positive or negative polarity	Yes • Yes	
Horizontal dynamic correction output HDyCor	No	
Composite HV dynamic correction output HVDyCor • Positive or negative polarity	No • No	
Shape control on H waveform component of HVDyCor output	No	
Tracking of horizontal waveform component with Horizontal size • EHT	No • No	
Tracking of vertical waveforms (component) with V. size & position	Yes	
DC • DC controller section		
Step-up • Step-down conversion mode	Yes • Yes	
Internal • External sawtooth configuration	No • Yes	
Bus-controlled output voltage • Inhibition at H unlock	Yes • Yes	
Mute • Soft start • Soft stop feature	Yes • Yes • Yes	
Positive (N-MOS) • Negative(P-MOS) polarity of BOut signal	Yes • Yes	
Phase selection • Max current selection • Frequency selection	Yes • Yes • Yes	

5 ABSOLUTE MAXIMUM RATINGS

All voltages are given with respect to ground.

Currents flowing from the device (sourced) are signed negative. Currents flowing to the device are signed positive.

Symbol	Parameter	Value		Unit
		Min	Max	
V_{CC}	Supply voltage (pin Vcc)	-0.4	13.5	V
$V_{(pin)}$	Pins HEHTIn, VEHTIn, XRay, HOut, BOut	-0.4	V_{CC}	V
	Pins H/HVSyn, VSyn, SCL, SDA	-0.4	5.5	V
	Pins HLckVBk, CO, RO, HPLL1F, HPosF, BRegIn, BISense, VAGCCap, VCap, VDyCor, HOscF, VOscF	-0.4	V_{RefO}	V
	Pin HPLL2C	-0.4	$V_{RefO}/2$	V
	Pin HFly	-0.4	V_{RefO}	V
$I_{latch(pin)}$	Latch-up current			
	All pins except XRay	-200	200	mA
	Pin XRay	-100	200	mA
V_{ESD}	ESD susceptibility (human body model: discharge of 100pF through 1.5kΩ)	-2000	2000	V
T_{stg}	Storage temperature	-40	150	°C
T_j	Junction temperature		150	°C

6 ELECTRICAL PARAMETERS AND OPERATING CONDITIONS

Medium (middle) value of an I²C-bus control or adjustment register composed of bits D0, D1,...,Dn is the one having Dn at "1" and all other bits at "0". Minimum value is the one with all bits at 0, maximum value is the one with all at "1".

Currents flowing from the device (sourced) are signed negative. Currents flowing to the device are signed positive.

T_H is period of horizontal deflection.

6.1 Thermal data

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
T_{amb}	Operating ambient temperature	0		70	°C
$R_{th(j-a)}$	Junction-ambience thermal resistance		65		°C/W

6.2 Supply and Reference voltages

T_{amb} = 25°C

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
V_{CC}	Supply voltage at Vcc pin		10.8	12	13.2	V
I_{CC}	Supply current to Vcc pin	V_{CC} = 12V		65		mA
V_{RefO}	Reference output voltage at RefOut pin	V_{CC} = 12V, I_{RefO}= -2mA	7.65	7.9	8.2	V
I_{RefO}	Current capability of RefOut output		-5		0	mA

6.3 Synchronization inputs

Vcc = 12V, T_{amb} = 25°C

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
$V_{LoH/HVSyn}$	LOW level voltage on H/HVSyn		0		0.8	V
$V_{HiH/HVSyn}$	HIGH level voltage on H/HVSyn		2.2		5	V
V_{LoVSyn}	LOW level voltage on VSyn		0		0.8	V
V_{HiVSyn}	HIGH level voltage on VSyn		2.2		5	V
R_{PdSyn}	Internal pull-down on H/HVSyn, VSyn		100	175	250	kΩ
$t_{PulseHSyn}$	H sync. pulse duration on H/HVSyn pin		0.5			µs
$t_{PulseHSyn}/T_H$	Proportion of H sync pulse to H period	Pin H/HVSyn			0.2	
$t_{PulseVSyn}$	V sync. pulse duration	Pins H/HVSyn, VSyn	0.5		750	µs
$t_{PulseVSyn}/T_V$	Proportion of V sync pulse to V period	Pins H/HVSyn, VSyn			0.15	
t_{extrV}/T_H	Proportion of H sync pulse length to H period for extraction as V sync pulse	Pin H/HVSyn, cap. on pin CO = 820pF	0.21	0.35		
$t_{HPolDet}$	Polarity detection time (after change)	Pin H/HVSyn	0.75			ms

6.4 Horizontal section

Table 1. Horizontal section (Vcc = 12V, T_{amb} = 25°C)

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
PLL1						
I_{RO}	Current load on RO pin				1.5	mA
C_{CO}	Capacitance on CO pin		390			pF
f_{HO}	Frequency of hor. oscillator				150	kHz
$f_{HO(0)}$	Free-running frequency of hor. oscill. (1)	R_{RO}=5.23kΩ, C_{CO}=820pF	27	28.5	29.9	kHz
f_{HOCapt}	Hor. PLL1 capture frequency (4)	$f_{HO(0)}$ = 28.5kHz	29		122	kHz
$\frac{\Delta f_{HO(0)}}{f_{HO(0)} \cdot \Delta T}$	Temperature drift of free-running freq. (3)			-150		ppm/°C
$\Delta f_{HO}/\Delta V_{HO}$	Average horizontal oscillator sensitivity	$f_{HO(0)}$ = 28.5kHz		20.2		kHz/V
V_{HO}	H. oscill. control voltage on pin HPLL1F	V_{RefO}=8V	1.4		6.0	V
$V_{HOThrfr}$	Threshold on H. oscill. control voltage on HPLL1F pin for tracking of EW with freq.	V_{RefO}=8V		5.0		V
V_{HPosF}	Control voltage on HPosF pin	***HPOS*** (Sad01h): 11111111b 10000000b 00000000b		 2.8 3.4 4.0		 V V V
$V_{HOThrLo}$	Bottom of hor. oscillator sawtooth(6)			1.6		V
$V_{HOThrHi}$	Top of hor. oscillator sawtooth(6)			6.4		V
PLL2						
$R_{In(HFly)}$	Input impedance on HFly input	$V_{(HFly)} > V_{ThrHFly}$ (2)	300	500	700	Ω
I_{InHFly}	Current into HFly input	At top of H flyback pulse			5	mA
$V_{ThrHFly}$	Voltage threshold on HFly input		0.5	0.6		V
$V_{S(0)}$	H flyback lock middle point(6)	No PLL2 phase modulation		4.0		V
$V_{BotHPLL2C}$	Low clamping voltage on HPLL2C pin(5)			1.6		V
$V_{TopHPLL2C}$	High clamping voltage on HPLL2C pin(5)			4.0		V
$t_{ph}(min)/T_H$	Min. advance of H-drive OFF before middle of H flyback(7)	Null asym. correction		0		%
$t_{ph}(max)/T_H$	Max. advance of H-drive OFF before middle of H flyback(8)	Null asym. correction		44		%
H-drive output on pin HOut						
I_{HOut}	Current into HOut output	Output driven LOW			30	mA
t_{Hoff}/T_H	Duty cycle of H-drive signal	f_H = 31kHz; ***HDUTY*** (Sad00h): x1111111b x0000000b Soft-start/Soft-stop value		 27 65 85		 % % %

Table 1. Horizontal section (Vcc = 12V, T_{amb} = 25°C)

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
Picture geometry corrections through PLL1 & PLL2						
t_{Hph}/T_H	Hor. VCO phase vs. sync signal (via PLL1), see Figure 7	***HPOS*** (Sad01h): 11111111b 10000000b 00000000b		 +11 0 -11		 % % %
t_{PCAC}/T_H	Contribution of pin cushion asymmetry correction to phase of H-drive vs. static phase (via PLL2), measured in corners	***PCAC*** (Sad11h) full span (9) ***VPOS*** at medium ***VSIZE*** at minimum ***VSIZE*** at medium ***VSIZE*** at maximum		 ±0.9 ±1.6 ±2.6		 % % %
t_{ParalC}/T_H	Contribution of parallelogram correction to phase of H-drive vs. static phase (via PLL2), measured in corners	***PARAL*** (Sad12h) full span (9) ***VPOS*** at medium ***VSIZE*** at minimum ***VSIZE*** at medium ***VSIZE*** at maximum		 ±1.4 ±1.9 ±2.4		 % % %
t_{TCAC}/T_H	Contribution of top corner asymmetry correction to phase of H-drive vs. static phase (via PLL2), measured in corners	***TCAC*** (Sad13h) full span (9) ***VPOS*** at medium ***VSIZE*** at minimum ***VSIZE*** at medium ***VSIZE*** at maximum		 ±0.4 ±1.4 ±3.5		 % % %
t_{BCAC}/T_H	Contribution of bottom corner asymmetry correction to phase of H-drive vs. static phase (via PLL2), measured in corners	***BCAC*** (Sad14h) full span (9) ***VPOS*** at medium ***VSIZE*** at minimum ***VSIZE*** at medium ***VSIZE*** at maximum		 ±0.4 ±1.4 ±3.5		 % % %

Notes about horizontal section

Note 1: Frequency at no sync signal condition. For correct operation, the frequency of the sync signal applied must always be higher than the free-running frequency. The application must consider the spread of values of real electrical components in R_{RO} and C_{CO} positions so as to always meet this condition. The formula to calculate the free-running frequency is $f_{HO(0)}=0.122/(R_{RO}\ C_{CO})$

Note 2: Base of NPN transistor with emitter to ground is internally connected on pin HFly through a series resistance of about 500Ω and a resistance to ground of about 20kΩ.

Note 3: Evaluated and figured out during the device qualification phase. Informative. Not tested on every single unit.

Note 4: This capture range can be enlarged by external circuitry.

Note 5: The voltage on HPLL2C pin corresponds to immediate phase of leading edge of H-drive signal on HOut pin with respect to internal horizontal oscillator sawtooth. It must be between the two clamping levels given. Voltage equal to one of the clamping values indicates a marginal operation of PLL2 or non-locked state.

Note 6: Internal threshold. See Figure 6.

Note 7: The t_{ph}(min) parameter is fixed by the application. For correct operation of asymmetry corrections through dynamic phase modulation, this minimum must be increased by maximum of the total dynamic phase required in the direction leading to bending of corners to the left. Marginal situation is indicated by reach of $V_{TopHPLL2C}$ high clamping level by waveform on pin HPLL2C. Also refer to Note 5 and Figure 6.

Notes about horizontal section (continued)

Note 8: The $t_{ph}(max)$ parameter is fixed by the application. For correct operation of asymmetry corrections through dynamic phase modulation, this maximum must be reduced by maximum of the total dynamic phase required in the direction leading to bending of corners to the right. Marginal situation is indicated by reach of $V_{BotHPLL2C}$ low clamping level by waveform on pin HPLL2C. Also refer to Note 5 and Figure 6.

Note 9: All other dynamic phase corrections of picture asymmetry set to their neutral (medium) positions.

6.5 Vertical section

Table 2. Vertical section (Vcc = 12V, Tamb = 25°C)

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
AGC-controlled vertical oscillator sawtooth; V_{RefO} = 8V						
$R_{L(VAGCCap)}$	Ext. load resistance on VAGCCap pin(10)	$\Delta V_{amp}/V_{amp}(R=\infty) \leq 1\%$	65			MΩ
V_{VOB}	Sawtooth bottom voltage on VCap pin(11)	No load on VOscF pin(11)		2		V
V_{VOTref}	Sawtooth top voltage internal reference			5		V
V_{VOT}	Sawtooth top voltage on VCap pin	AGC loop stabilized		5		V
t_{VODis}	Sawtooth Discharge time	C_{VCap}=150nF		80		µs
$f_{VO(0)}$	Free-running frequency	C_{VCap}=150nF		100		Hz
f_{VOCapt}	AGC loop capture frequency	C_{VCap}=150nF	50		185	Hz
$\frac{\Delta V_{VOdev}}{V_{VOamp}}$	Sawtooth non-linearity(12)(17)	AGC loop stabilized (12)		0.5		%
$\frac{\Delta V_{VOamp}}{V_{VOamp} \cdot \Delta f_{VO}}$	Frequency drift of sawtooth amplitude(18)(19)	AGC loop stabilized $f_{VOCapt(min)} \leq f_{VO} \leq f_{VOCapt(max)}$		200		ppm/Hz
Vertical output drive signal (on pin VOut); V_{RefO} = 8V						
V_{midref}	Internal reference for vertical sawtooth middle point			3.5		V
$V_{mid(VOut)}$	Middle point on VOut sawtooth	***VPOS*** (Sad08h):(22) x0000000b x1000000b x1111111b ***VPOF*** (Sad1Eh):(21) x0000000b x1000000b x1111111b	3.65	 3.1 3.45 3.8 3.3 3.45 3.6	 3.3	 V V V V V V
V_{amp}	Amplitude of VOut sawtooth (peak-to-peak voltage)	***VSIZE*** (Sad07h):(23) x0000000b x1000000b x1111111b ***VSAG*** (Sad1Dh):(20) x0000000b x1000000b x1111111b	3.5	 2.25 3.0 3.75 2 2.5 3.0	 2.5	 V V V V V V
$V_{offVOut}$	Level on VOut pin at V-drive "off"	I²C-bus bit VOutEn at 0		4.0		V

Table 2. Vertical section (Vcc = 12V, Tamb = 25°C)

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
I_{VOut}	Current delivered by VOut output		-5		0.25	mA
V_{SCor}/V_{amp}	S-correction range	(13)(20)(21) AGC loop stabilized t_{VR}=1/4 T_{VR}(15) t_{VR}=3/4 T_{VR}		 -4.5 +4.5		 % %
V_{CCor}/V_{amp}	C-correction range	(14)(20)(21) AGC loop stabilized t_{VR}=1/2 T_{VR}(15) ***CCOR***(Sad0Ah): x0000000b x1000000b x1111111b		 -2.5 0 +2.5		 % % %
V_{VEHT}	Control input voltage range on-VEHTIn pin		1	4	6	V
$V_{VEHTnull}$	Neutral point on breathing characteristics(16)			4.0		V
$\frac{\Delta V_{amp}}{V_{amp} \cdot \Delta V_{VEHT}}$	Breathing compensation	$V_{RefO} < V_{VEHT} < V_{CC}$ $V_{VEHT(min)} \leq V_{VEHT} \leq V_{VEHT(max)}$: ***VEHTG*** (Sad1Ch): x0000000b x1000000b x1111111b		0 5 0 -5		%/V %/V %/V %/V

Notes about vertical section

Note 10: Value of acceptable cumulated parasitic load resistance due to humidity, AGC storage capacitor leakage, etc., for less than 1% of V_{amp} change.

Note 11: The threshold for V_{VOB} is generated internally and routed to VOscF pin. Any DC current on this pin will influence the value of V_{VOB}.

Note 12: Maximum of deviation from an ideally linear sawtooth ramp at null S-correction (***SCOR*** at 0000000b) and null C-correction (***CCOR*** at 1000000b). The same rate applies to V-drive signal on VOut pin, no effect on EWOut.

Note 13: Maximum S-correction (***SCOR*** at x1111111b), null C-correction (***CCOR*** at 1000000b).

Note 14: Null S-correction (***SCOR*** at 0000000b).

Note 15: "t_{VR}" is time from the beginning of vertical ramp of V-drive signal on VOut pin. "T_{VR}" is the duration of this ramp, see Chapter 7 - page 21 and Figure 17.

Note 16: If V_{VEHT}=$V_{VEHTnull}$ or V_{HEHT}=$V_{HEHTnull}$, respectively, the influence of V_{VEHT} on vertical drive amplitude or the influence of V_{HEHT} on EW drive signal, respectively, is null.

Note 17: V_{VOamp} = V_{VOT} -V_{VOB}

Note 18: Only the top of the saw tooth drifts. The same rate applies to V-drive signal on VOut pin.

Note 19: Informative, not tested on each unit.

Note 20: ***VSIZE*** at medium value 1000000b.

Note 21: ***VPOS*** at medium value 1000000b.

Note 22: ***VPOF*** at medium value 1000000b.

Note 23: ***VSAG*** at maximum value 1111111b.

6.6 EW drive section

Table 3. EW drive section (V_{CC} = 12V, T_{amb} = 25°C)

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
V_{EW}	Output voltage on EWOut pin		1.8		6.5	V
I_{EWOut}	Current delivered by EWOut output		-1.5		0.1	mA
V_{HEHT}	Control voltage range on HEHTIn pin		1		6	V
$V_{HEHTnull}$	Neutral point on breathing characteristics. See Figure 15.(16)			4.0		V
V_{EW-DC}	DC component of the EW-drive signal on EWOut pin(30)	(24)(25)(26)(27)(28)(36)(42)(43) EWTrHFr=0 or V_{HO}>$V_{HOThrfr}$ ***HSIZE*** (Sad10h): 00000000b 10000000b 11111111b		 2 3.25 4.5		 V V V
$V_{EW-base}$	DC reference for the EW-drive signal on EWOut pin			2		V
$\frac{\Delta V_{EW-DC}}{\Delta V_{HEHT}}$	Breathing compensation on DC component of the EW-drive signal(30)	(24)(25)(26)(27)(42)(43) $V_{RefO} < V_{HEHT} < V_{CC}$ $V_{HEHT(min)} \leq V_{HEHT} \leq V_{HEHT(max)}$: ***HEHTG*** (Sad1Bh): x0000000b x1000000b x1111111b		0 0 -0.25 0 +0.25		V/V V/V V/V V/V V/V
$\frac{\Delta V_{EW-DC}}{V_{EW-DC} \cdot \Delta T}$	Temperature drift of DC component of the EW-drive signal(30)	(24)(25)(26)(27)(28)(36)(42)(43)(44)		100		ppm/°C
V_{EW-PCC}	Pin cushion correction component of the EW-drive signal	(24)(25)(26)(28)(29)(31)(32)(36)(42)(43) ***VSIZE*** at maximum ***PCC*** (Sad0Ch): x0000000b x1000000b x1111111b Tracking with ***VSIZE***: ***PCC*** at x1000000b ***VSIZE*** (Sad07h): x0000000b x1000000b		 0 0.75 1.5 0.25 0.5		 V V V V V
$\frac{V_{EW-PCC}[t_{vr}=0]}{V_{EW-PCC}[t_{vr}=T_{VR}]}$	Tracking of PCC component of the EW-drive signal with vertical position adjustment	(24)(25)(26)(29)(33)(35)(36)(42)(43) ***PCC*** at x1111111b ***VPOS*** (Sad08h): x0000000b x1111111b		 0.5 2.0		
V_{EW-Key}	Keystone correction component of the EW-drive signal	(25)(26)(27)(28)(29)(33)(34)(36)(42)(43) ***KEYST*** (Sad0Dh): x0000000b x1111111b		 0.4 -0.4		 V V

Table 3. EW drive section (V_{CC} = 12V, T_{amb} = 25°C)

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
$V_{EW\text{-}TCor}$	Top corner correction component of the EW-drive signal	(24)(26)(27)(28)(29)(31)(33)(36)(42)(43) ***TCC*** (Sad0Eh): x0000000b x1000000b x1111111b		 -1.4 0 +1.4		 V V V
$V_{EW\text{-}BCor}$	Bottom corner correction component of the EW-drive signal	(24)(25)(27)(28)(29)(32)(33)(36)(42)(43) ***BCC*** (Sad0Fh): x0000000b x1000000b x1111111b		 -1.4 0 +1.4		 V V V
$V_{EW\text{-}S}$	Pin Cushion S correction component of EW-drive signal	(24)(25)(26)(27)(28)(29)(33)(36)(41)(43) ***EWSC*** (Sad19h): x0000000b x1000000b x1111111b		 -0.3 0 0.3		 V V V
$V_{EW\text{-}W}$	Pin Cushion W correction component of EW-drive signal	(24)(25)(26)(27)(28)(29)(33)(36)(41)(42) ***EWWC*** (Sad1Ah): x0000000b x1000000b x1111111b		 -0.1 0 0.1		 V V V
$\frac{\Delta V_{EW-AC}}{V_{EW-AC}[f_{max}] \cdot \Delta V_{HO}}$	Tracking of AC component of EW-drive signal with horizontal frequency(37)(38)(39)	I²C bit EWTrHFr=1 $V_{HO} > V_{HOThrfr}$ $V_{HO}(min) \leq V_{HO} \leq V_{HOThrfr}$		0 20		%/V %/V
$\frac{\Delta V_{EW-DC}}{V_{EW-DC}[span] \cdot \Delta V_{HO}}$	Tracking of DC component of EW-drive signal with horizontal frequency(30)(38)(39)	I²C bit EWTrHFr=1 $V_{HO} > V_{HOThrfr}$ $V_{HO}(min) \leq V_{HO} \leq V_{HOThrfr}$		0 20		%/V %/V
$\frac{V_{EW-AC}}{V_{EW-AC}[\textbf{\textit{HSIZE}}_{max}]}$	Tracking of AC component of EW-drive signal with horizontal size(37)	I²C bit EWTrHSize=1 ***HSIZE*** (Sad10h): 00000000b 10000000b 11111111b		 138 119 100		 % % %
$\frac{\Delta V_{EW-AC}}{V_{EW-AC} \cdot \Delta V_{HEHT}}$	Breathing compensation on AC component of the EW-drive signal(37)	$V_{RefO} < V_{HEHT} < V_{CC}$ $V_{HEHT}(min) \leq V_{HEHT} \leq V_{HEHT}(max)$: ***HEHTG*** (Sad1Bh): 0000000b 1000000b 1111111b		0 3.5 0 -3.5		%/V %/V %/V %/V

Notes about EW drive section

Note 24: ***KEYST*** at medium (neutral) value.

Note 25: ***TCC*** at medium (neutral) value.

Note 26: ***BCC*** at medium (neutral) value.

Note 27: ***PCC*** at minimum value.

Note 28: ***VPOS*** at medium (neutral) value.

Note 29: ***HSIZE*** I²C field at maximum value.

Note 30: $V_{EW\text{-}DC}$ is defined as voltage at t_{VR}=1/2 T_{VR}.

Note 31: Defined as difference of (voltage at t_{VR}=0) minus (voltage at t_{VR}=1/2 T_{VR}).

Note 32: Defined as difference of (voltage at t_{VR}=T_{VR}) minus (voltage at t_{VR}=1/2 T_{VR}).

Note 33: ***VSIZE*** at maximum value.

Note 34: Difference (voltage at t_{VR}=0) minus (voltage at t_{VR}=T_{VR}).

Note 35: Ratio "A/B"of parabola component voltage at t_{VR}=0 versus parabola component voltage at t_{VR}=T_{VR}. See Figure 2.

Note 36: V_{HEHT}>V_{RefO}, V_{VEHT}>V_{RefO}

Note 37: $V_{EW\text{-}AC}$ is defined as overall peak-to-peak value between t_{VR}=0 and t_{VR}=T_{VR} of all components other than $V_{EW\text{-}DC}$ (contribution of PCC, keystone correction, corner corrections and S- and W-corrections).

Note 38: More precisely tracking with voltage on HPLL1F pin which itself depends on frequency at a rate given by external components on PLL1 pins

Note 39: $V_{EW\text{-}DC}$[span] = $V_{EW\text{-}DC}$[V_{HO}>$V_{HOThrfr}$] - $V_{EW\text{-}DC}$[***HSIZE***=0000000b].
$V_{EW\text{-}AC}$[f_{max}] = $V_{EW\text{-}AC}$[V_{HO}>$V_{HOThrfr}$].

Note 40: Defined as difference of (voltage at t_{VR}=1/4 T_{VR}) minus (voltage at t_{VR}=3/4 T_{VR}).

Note 41: Defined as difference of (voltage at t_{VR}=1/2 T_{VR}) minus (voltage at t_{VR}=1/4 T_{VR}).

Note 42: ***EWSC*** at medium (neutral) value.

Note 43: ***EWWC*** at medium (neutral) value.

Note 44: Informative, not tested on each unit.

6.7 Dynamic correction outputs section

Table 4. Dynamic correction outputs section (V_{CC} = 12V, T_{amb} = 25°C)

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
Vertical Dynamic Correction output VDyCor						
I_{VDyCor}	Current delivered by VDyCor output		-1.5		0.1	mA
V_{VD-DC}	DC component of the drive signal on VDyCor output	$R_{L(VDyCor)}$=10kΩ		4		V
V_{VD-V}	Amplitude of V-parabola on VDyCor output	(28) ***VSIZE*** at medium ***VDC-AMP*** (Sad15h): x0000000b x1000000b x1111111b ***VDC-AMP*** at maximum ***VSIZE*** (Sad07h): x0000000b x1111111b		 0 0.5 1 0.6 1.6		 V V V V V
$\frac{V_{VD-V}[t_{VR}=0]}{V_{VD-V}[t_{VR}=T_{VR}]}$	Tracking of V-parabola on VDyCor output with vertical position (45)	***VDC-AMP*** at maximum ***VPOS*** (Sad08h): x0000000b x1111111b		 0.5 2.0		

Notes about dynamic output section

Note 45: Ratio "A/B"of vertical parabola component voltage at t_{VR}=0 versus vertical parabola component voltage at t_{VR}=T_{VR}.

6.8 DC/DC controller section

Table 5. DC/DC controller section (V_{CC} = 12V, T_{amb} = 25°C)

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
R_{B+FB}	Ext. resistance applied between BComp output and BRegIn input		5			kΩ
A_{OLG}	Open loop gain of error amplifier on BRegIn input	Low frequency(19)		100		dB
f_{UGBW}	Unity gain bandwidth of error amplifier on BRegIn input	(19)		6		MHz
I_{RI}	Bias current delivered by BRegIn			-0.2		µA
I_{BComp}	Output current capability of BComp output.	BOut enabled BOut disabled(46)	-0.5	 0.5	2.0	mA mA
$A_{BISense}$	Voltage gain on BISense input			3		
$V_{ThrBIsCurr}$	Threshold voltage on BISense input corresponding to current limitation	ThrBIsense = 0 ThrBIsense = 1	TBD TBD	2.1 1.2		V
$I_{BISense}$	Bias current delivered by BISense			-1		µA
t_{BOn}	Conduction time of the power transistor				T_H - 300ns	
I_{BOut}	Output current capability of BOut output		0		10	mA
V_{BOSat}	Saturation voltage of the internal output transistor on BOut	I_{BOut}=10mA		0.25		V
V_{BReg}	Regulation reference for BRegIn voltage(47)	V_{RefO}=8V ***BREF*** (Sad03h): x0000000b x1000000b x1111111b		 3.8 4.9 6.0		 V V V
$t_{BTrigDel}/T_H$	Delay of BOut “Off-to-On” edge after middle of flyback pulse (48)	BOutPh = 0 and BOHEdge = 0		16		%

Note 46: A current sink is provided by the BComp output while BOut is disabled.

Note 47: Internal reference related to V_{RefO}. The same values to be found on pin BRegIn, while regulation loop is stabilized.

Note 48: Only applies to configuration specified in "Test conditions" column, i.e. synchronization of BOut “Off-to-On” edge with horizontal fly-back signal. Refer to chapter "DC/DC controller" for more details.

6.9 Miscellaneous

Table 6. Miscellaneous (V_{CC} = 12V, T_{amb} = 25°C)

Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
Vertical blanking and horizontal lock indication composite output HLckVBk						
$I_{SinkLckBk}$	Sink current to HLckVBk pin	(49)		100		µA
V_{OLckBk}	Output voltage on HLckVBk output	V. blank / H. lock No / Yes Yes / Yes No / No Yes / No		0.1 1.1 5 6		V V V V
Horizontal moiré canceller						
$\frac{\Delta T_{H(H-moire)}}{T_H}$	Modulation of T_H by H. moiré function	HMoiréMode = 0 ***HMOIRE*** (Sad02h): x0000000b x1111111b HMoiréMode = 1 ***HMOIRE*** (Sad02h): x0000000b x1111111b		 0 0.02 0 0.04		 % % % %
Vertical moiré canceller						
$V_{V\text{-}moiré}$	Amplitude of modulation of V-drive signal on VOut pin by vertical moiré.	***VMOIRE*** (Sad0Bh): x0000000b x1111111b		 0 3		 mV mV
Protection functions						
$V_{ThrXRay}$	Input threshold on XRay input(50)		V_{RefO} -10mV	V_{RefO}	V_{RefO} +10mV	
$t_{XRayDelay}$	Delay time between XRay detection event and protection action		T_H		$2T_H$	
$V_{CCXRayEn}$	Minimum V_{CC} value for operation of XRay detection and protection(53)			10.2	10.8	V
V_{CCEn}	V_{CC} value for start of operation at V_{CC} ramp-up(51)			8.0		V
V_{CCDis}	V_{CC} value for stop of operation at V_{CC} ramp-down(51)			6.8		V
Control voltages on HPosF pin and V_{CC} for Soft start/stop operation(19)(52)						
V_{HOn}	Threshold for start/stop of H-drive signal			1		V
V_{BOn}	Threshold for start/stop of B-drive signal			1.7		V
V_{HBNorm}	Threshold for full operation duty cycle of H-drive and B-drive signals			2.4		
V_{CCStop}	Minimum supply voltage when voltage on HPosF pin reaches V_{HOn} threshold(54)			4.8		

Notes about Miscellaneous section

Note 49: Current sunk by the pin if the external voltage is higher than one the circuit tries to force.

Note 50: See V_{RefO} in Section 6.2.

Note 51: In the regions of V_{CC} where the device's operation is disabled, the H-drive, V-drive and B+-drive signals on HOut, VOut and BOut pins, resp., are inhibited, the I²C-bus does not accept any data and the XRayAlarm flag is reset. Also see Figure 10.

Note 52: See Figure 10.

Note 53: When V_{CC} is below $V_{CCXRayEn}$ XRay detection and protection are disabled.

Note 54: Minimum momentary supply voltage to ensure a correct performance of Soft stop function at V_{CC} fall down is defined at the moment when the voltage on HPosF pin reaches V_{HOn} threshold.

7 TYPICAL OUTPUT WAVEFORMS

Table 7. Typical output waveforms - Note 55

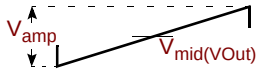
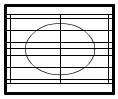
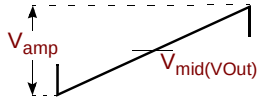
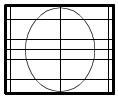
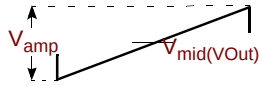
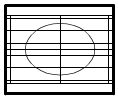
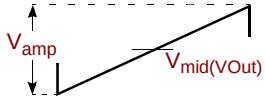
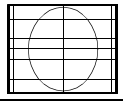
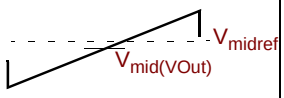
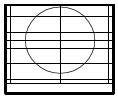
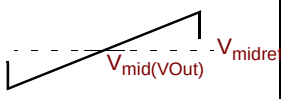
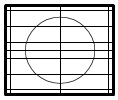
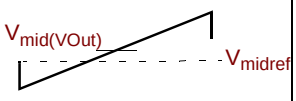
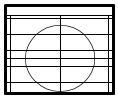
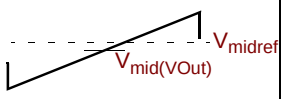
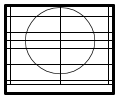
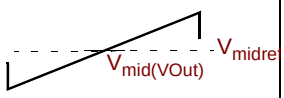
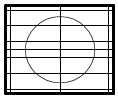
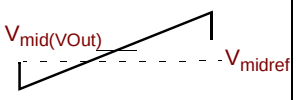
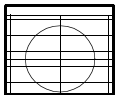
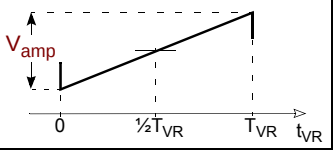
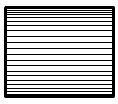
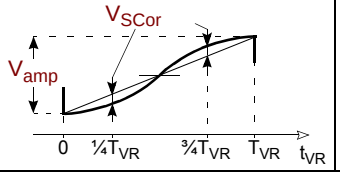
Function	Sad	Pin	Byte	Waveform	Effect on Screen
Vertical Size	07	VOut (23)	x0000000		
			x1111111		
Vertical Size After Gain	1D	VOut (23)	x0000000		
			x1111111		
Vertical Position	08	VOut (23)	x0000000		
			x1000000		
			x1111111		
Vertical Position Offset	1E	VOut (23)	x0000000		
			x1000000		
			x1111111		
S-correction	09	VOut (23)	x0000000: Null		
			x1111111: Max.		

Table 7. Typical output waveforms - Note 55

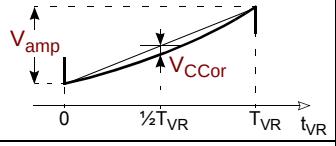
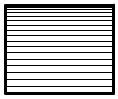
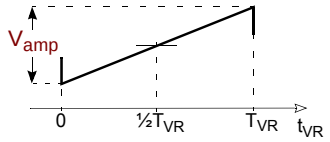
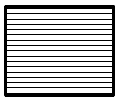
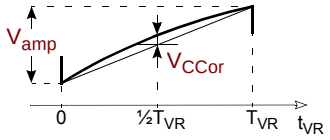
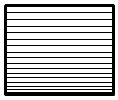
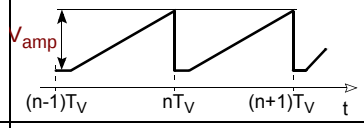
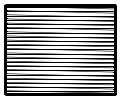
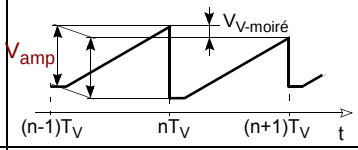
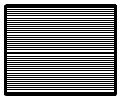
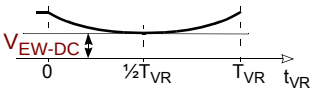
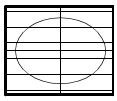
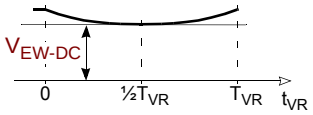
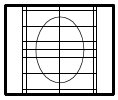
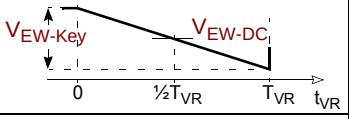
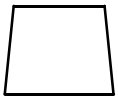
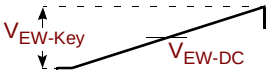
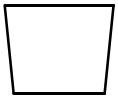
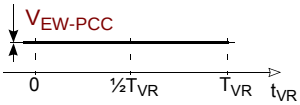
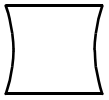
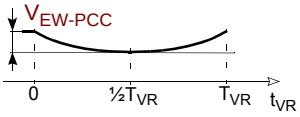
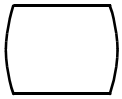
Function	Sad	Pin	Byte	Waveform	Effect on Screen
C-correction	0A	VOut (23)	x0000000		
			x1000000 : Null		
			x1111111		
Vertical moiré amplitude	0B	VOut (23)	x0000000: Null		
			x1111111: Max.		
Horizontal size	10h	EWOut (24)	00000000		
			11111111		
Keystone correction	0D	EWOut (24)	x0000000		
			x1111111		
Pin cushion correction	0C	EWOut (24)	x0000000		
			x1111111		

Table 7. Typical output waveforms - Note 55

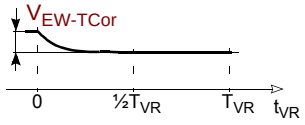
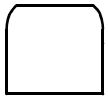
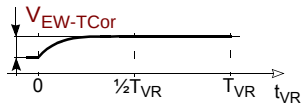
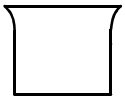
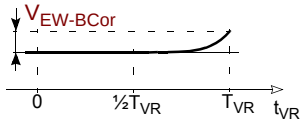
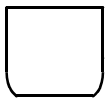
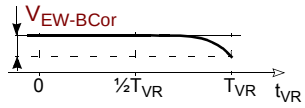
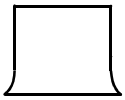
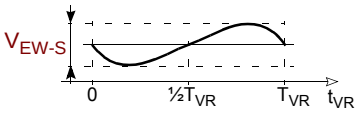
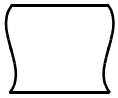
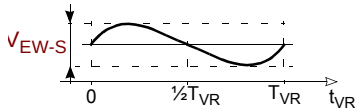
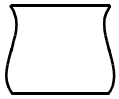
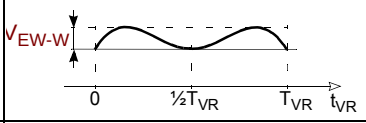
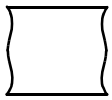
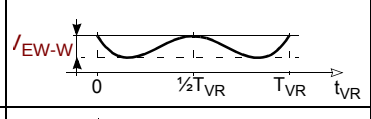
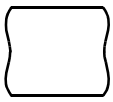
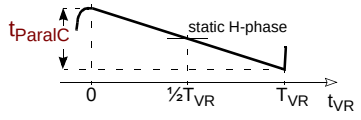
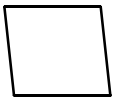
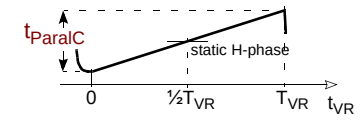
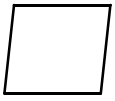
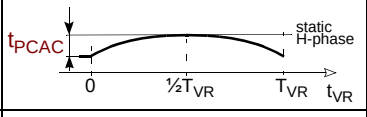
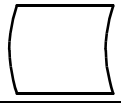
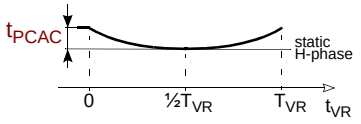
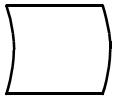
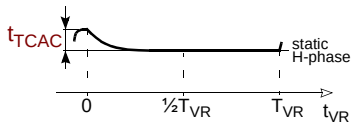
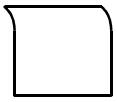
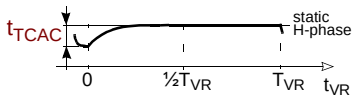
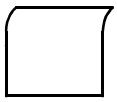
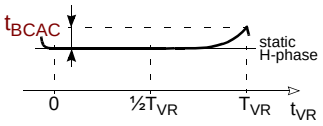
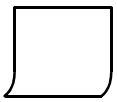
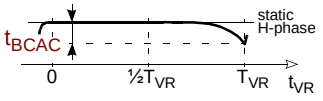
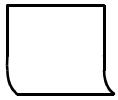
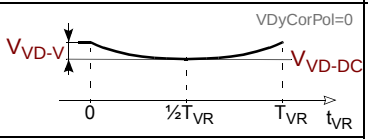
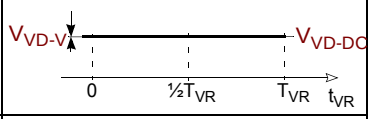
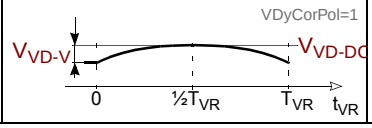
Function	Sad	Pin	Byte	Waveform	Effect on Screen
Top corner correction	0E	EWOut (24)	x1111111		
			x0000000		
Bottom corner correction	0F	EWOut (24)	x1111111		
			x0000000		
Pin Cushion S-correction	19	EWOut (24)	x1111111		
			x0000000		
Pin Cushion W-correction	1A	EWOut (24)	x1111111		
			x0000000		
Parallelogram correction	12h	Internal	x0000000		
			x1111111		
Pin cushion asymmetry correction	11h	Internal	x0000000		
			x1111111		

Table 7. Typical output waveforms - Note 55

Function	Sad	Pin	Byte	Waveform	Effect on Screen
Top corner asymmetry correction	13h	Internal	x0000000		
			x1111111		
Bottom corner asymmetry correction	14h	Internal	x0000000		
			x1111111		
Vertical dynamic correction amplitude	15h	VDyCor (32)	01111111		Application dependent
			x0000000		
			11111111		

Note 55: For any H and V correction component of the waveforms on EWOut and VOut pins and internal waveform for corrections of H asymmetry, displayed in the table, the weight of the other relevant components is nullified (minimum for parabola, S-correction, medium for keystone, all corner corrections, C-correction, S- and W-pin cushion corrections, parallelogram, pin cushion asymmetry correction, written in corresponding registers).

8 I²C-BUS CONTROL REGISTER MAP

The device slave address is 8C in write mode and 8D in read mode. The control register map is given in Table .

Bold weight denotes default value at Power-On-Reset.
I²C-bus data in the adjustment register is buffered and internally applied with discharge of the vertical oscillator (56).
In order to ensure compatibility with future devices, all “Reserved” bits should be set to 0.

Table 8. I²C-bus control registers

Sad	D7	D6	D5	D4	D3	D2	D1	D0
WRITE MODE (SLAVE ADDRESS = 8C)								
00	HDutySyncV 1: Synchro. **0**: Asynchro.	***HDUTY Horizontal duty cycle***						
		0	**0**	**0**	**0**	**0**	**0**	**0**
01		***HPOS Horizontal position***						
	1	**0**	**0**	**0**	**0**	**0**	**0**	**0**
02	HMoiréMode 1: Separated **0**: Combined	***HMOIRE Horizontal moiré amplitude***						
		0	**0**	**0**	**0**	**0**	**0**	**0**
03	B+SyncV **0**: Asynchro.	***BREF B+reference***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
04	Reserved							
05	Reserved							
06	BOutPol **0**: Type N	Reserved						
07	BOutPh **0**: H-flyback 1: H-drive	***VSIZE Vertical size***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
08	EWTrHFr **0**: No tracking	***VPOS Vertical position***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
09	Reserved	***SCOR S-correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
0A	Reserved	***CCOR C-correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
0B	Reserved	***VMOIRE Vertical moiré amplitude***						
		0	**0**	**0**	**0**	**0**	**0**	**0**
0C	Reserved	***PCC Pin cushion correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
0D	Reserved	***KEYST Keystone correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
0E	Reserved	***TCC Top corner correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
0F	Reserved	***BCC Bottom corner correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
10		***HSIZE Horizontal size***						
	1	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 8. I²C-bus control registers

Sad	D7	D6	D5	D4	D3	D2	D1	D0
11	Reserved	***PCAC Pin cushion asymmetry correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
12	Reserved	***PARAL Parallelogram correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
13	Reserved	***TCAC Top corner asymmetry correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
14	Reserved	***BCAC Bottom corner asymmetry correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
15	VDyCorPol **0**: "∪"	***VDC-AMP Vertical dynamic correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
16	XRayReset **0**: No effect 1: Reset	VSyncAuto **1**: On	VSyncSel 0:Comp **1**:Sep	SDetReset **0**: No effect 1: Reset	PLL1Pump 1,1: Fastest **0,0**: Slowest		PLL1InhEn **1**: On	HLockEn **1**: On
17	TV **0**: Off(58)	TH **0**: Off(58)	TVM **0**: Off(58)	THM **0**: Off(58)	BOHEdge **0**: Falling	HBOutEn **0**: Disable	VOutEn **0**: Disable	BlankMode **1**: Perm.
18	Reserved							
19	Reserved **0**:	***EWSC East-West S-correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
1A	Reserved **0**:	***EWWC East-West W-correction***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
1B	Reserved **0**:	***HEHTG Horizontal EHT compensation gain***						
		0	**0**	**0**	**0**	**0**	**0**	**0**
1C	Reserved **0**:	***VEHTG Vertical EHT compensation gain***						
		0	**0**	**0**	**0**	**0**	**0**	**0**
1D	Reserved **0**:	***VSAG Vertical size after-gain***						
		1	**1**	**1**	**0**	**0**	**0**	**0**
1E	Reserved **0**:	***VPOF Vertical position offset***						
		1	**0**	**0**	**0**	**0**	**0**	**0**
1F	ThrBlsense **0:** High	BMute **0**: Off	BSafeEn **0**: Disable	EWTrHSize **0**: Tracking	Ident **0:** No effect	HLockSpeed **0:** Slow	Reserved	Reserved
READ MODE (SLAVE ADDRESS = 8D)								
XX(57)	HLock 0: Locked **1**: Not locked	VLock 0: Locked **1**: Not lock.	XRayAlarm 1: On **0**: Off	***Polarity detection*** HVPol **1**: Negative	 VPol **1**: Negative	***Sync detection*** VExtrDet **0**: Not det.	 HVDet **0**: Not det.	 VDet **0**: Not det.

Note 56: With exception of ***HDUTY*** and ***BREF*** adjustments data that can take effect instantaneously if switches HDutySyncV and B+SyncV are at 0, respectively.

Note 57: In Read Mode, the device always outputs data of the status register, regardless of sub address previously selected.

Note 58: The TV, TH, TVM and THM bits are for testing purposes and must be kept at 0 by application.

DESCRIPTION OF I²C-BUS SWITCHES AND FLAGS

Write-to bits

Sad00h/D7 - HDutySyncV

Synchronization of internal application of **H**orizontal **Duty** cycle data, buffered in I²C-bus latch, with internal discharge of **V**ertical oscillator.

0: Asynchronous mode, new data applied with ACK bit of I²C-bus transfer on this sub address

1: Synchronous mode

Sad02h/D7 - HMoiréMode

Horizontal **Moiré** characteristics.

0: Adapted to an architecture with EHT generated in deflection section

1: Adapted to an architecture with separated deflection and EHT sections

Sad03h/D7 - B+SyncV

Same as HDutySyncV, applicable for **B+** reference data

Sad06h/D7 - BOutPol

Polarity of B+ drive signal on BOut pin.

0: adapted to N type of power MOS - high level to make it conductive

1: adapted to P type of power MOS - low level to make it conductive

Sad07h/D7 - BOutPh

Phase of start of B+ drive signal on BOut pin

0: End of horizontal flyback or horizontal frequency divided by 2, see BOHEdge bit.

1: With one of edges of line drive signal on HOut pin, selected by BOHEdge bit

Sad08h/D7 - EWTrHFr

Tracking of all corrections contained in waveform on pin EWOut with **H**orizontal **Fr**equency

0: Not active

1: Active

Sad15h/D7 - VDyCorPol

Polarity of **V**ertical **Dy**namic **Cor**rection waveform (parabola)

0: Concave (minimum in the middle of the parabola)

1: Convex (maximum in the middle of the parabola)

Sad16h/D0 - HLockEn

Enable of output of **H**orizontal PLL1 **Lock**/unlock status signal on pin HLckVBk

0: Disabled, vertical blanking only on the pin HLckVBk

1: Enabled

Sad16h/D1 - PLL1InhEn

Enable of **Inh**ibition of horizontal **PLL1** during extracted vertical synchronization pulse

0: Disabled, PLL1 is never inhibited

1: Enabled

Sad16h/D2 and D3- PLL1Pump

Horizontal **PLL1** charge **Pump** current

D3	D2	Time Constant
0	0	Slowest PLL1, lowest current
1	0	Moderate Slow PLL1, low current
0	1	Moderate Fast PLL1, high current
1	1	Fastest PLL1, highest current

Sad16h/D4 - SDetReset

Reset to 0 of **S**ynchronization **Det**ection flags VDet, HVDet and VExtrDet of status register effected with ACK bit of I²C-bus data transfer into register containing the SDetReset bit. Also see description of the flags.

0: No effect

1: Reset with automatic return of the bit to 0

Sad16h/D5 - VSyncSel

Vertical **Sync**hronization input **Sel**ection between the one extracted from composite HV signal on pin H/HVSyn and the one on pin VSyn. No effect if VSyncAuto bit is at 1.

0: V. sync extracted from composite signal on H/HVSyn pin selected

1: V. sync applied on VSyn pin selected

Sad16h/D6 - VSyncAuto

Vertical **Sync**hronization input selection **Auto**-matic mode. If enabled, the device automatically selects between the vertical sync extracted from composite HV signal on pin H/HVSyn and the one on pin VSyn, based on detection mechanism. If both are present, the one coming first is kept.

0: Disabled, selection done according to bit VSyncSel

1: Enabled, the bit **VSyncSel** has no effect

Sad16h/D7 - XRayReset

Reset to 0 of **XRay** flag of status register effected with ACK bit of I²C-bus data transfer into register containing the XRayReset bit. Also see description of the flag.

0: No effect
1: Reset with automatic return of the bit to 0

Sad17h/D0 - BlankMode

Blanking operation **Mode**.

0: Blanking pulse starting with detection of vertical synchronization pulse and ending with end of vertical oscillator discharge (start of vertical sawtooth ramp on the VOut pin)
1: Permanent blanking - high blanking level in composite signal on pin HLckVBk is permanent

Sad17h/D1 - VOutEn

Vertical **Out**put **En**able.

0: Disabled, $V_{offVOut}$ on VOut pin (see Section 6.5 Vertical section)
1: Enabled, vertical ramp with vertical position offset on VOut pin

Sad17h/D2 - HBOutEn

Horizontal and **B**+ **Out**put **En**able.

0: Disabled, levels corresponding to “power transistor off” on HOut and BOut pins (high for HOut, high or low for BOut, depending on **BOutPol** bit).
1: Enabled, horizontal deflection drive signal on HOut pin providing that it is not inhibited by another internal event (activated XRay protection). B+ drive signal on BOut pin if not inhibited by another internal event.

Programming the bit to 1 after prior value of 0, will initiate soft start mechanism of horizontal drive and, if this is not inhibited by another internal event, also the soft start of B+ DC/DC convertor controller. See also bits BMute and BSafeEn.

Sad17h/D3 - BOHEdge

If the bit BOutPh is at 1, selection of **Edge** of **H**orizontal drive signal to phase **B**+ drive **O**utput signal on BOut pin.

1: Rising edge
0: Falling edge

If the bit BOutPh is at 0, selection of signal to phase **B**+ drive output on BOut pin:

1: Horizontal frequency divided by 2 signal, top of horizontal VCO
0: End of horizontal flyback

Sad17h/D4,D5,D6,D7 - THM, TVM, TH, TV

Test bits. They must be kept at 0 level by application S/W.

Sad1Fh/D2 - HLockSpeed

Response **Speed** of lock-to-unlock transition of H-lock component on **HLock** output and HLock I²C-bus flag at signal change.

0: Low
1: High

Sad1Fh/D3 - Ident

Device **Ident**ification bit.
If HBOutEn is at 1, the bit has no effect.
If HBOutEn is at 0, then

0: The value of Hlock status bit is 1
1: The value of Hlock status bit is 0

Sad1Fh/D4 - EWTrHSize

Tracking of all corrections contained in waveform on pin **EW**Out with **H**orizontal **Size** I²C-bus register ***HSIZE***.

0: Active
1: Not active

Sad1Fh/D5 - BSafeEn

B+ Output **Safe**ty **En**able.

0: Disabled
1: Enabled, BOut goes off as soon as HLock status of Horizontal PLL1 indicates “unlock” state. Retrieval of “lock” state will initiate soft start mechanism of DC/DC controller on BOut output.

Sad1Fh/D6 - BMute

B+ Output **Mute**.

0: Disabled
1: Enabled, BOut goes unconditionally off. Programming this bit back to 0 will initiate soft start mechanism of DC/DC controller on BOut output.

Sad1Fh/D7 - ThrBIsense

Threshold on BISense input corresponding to current limitation.

0: High
1: Low

Read-out flags

SadXX/D0 - VDet[59]

Flag indicating **Det**ection of **V** synchronization pulses on VSyn pin.

0: Not detected
1: Detected

SadXX/D1 - HVDet [59]

Flag indicating **Det**ection of **H** or H**V** synchronization pulses applied on H/HVSyn pin. Once the sync pulses are detected, the flag is set and latched. Disappearance of the sync signal will not lead to reset of the flag.

0: Not detected
1: Detected.

SadXX/D2 - VExtrDet [59]

Flag indicating **Det**ection of **Extr**acted **V**ertical synchronization signal from composite H+V signal applied on H/HVSyn pin.

0: Not detected
1: Detected

SadXX/D3 - VPol

Flag indicating **Pol**arity of **V** synchronization pulses applied on VSyn pin with respect to mean level of the sync signal.

0: Positive
1: Negative

SadXX/D4 - HVPol

Flag indicating **Pol**arity of **H** or H**V** synchronization pulses applied on H/HVSyn pin with respect to mean level of the sync signal.

0: Positive
1: Negative

SadXX/D5 - XRayAlarm

Alarm indicating that an event of excessive voltage has passed on XRay pin. Can only be reset to 0 through I²C-bus bit XRayReset or by power-on reset.

0: No excess since last reset of the bit
1: At least one event of excess appeared since the last reset of the bit, HOut inhibited

SadXX/D6 - VLock

Status of "**Lock**ing" or stabilizing of **V**ertical oscillator amplitude to an internal reference by AGC regulation loop.

0: Locked (amplitude stabilized)
1: Not locked (amplitude non-stabilized)

SadXX/D7 - HLock

Lock status of **H**orizontal PLL1.

0: Locked
1: Not locked

See also bit Ident **(**Sad1Fh/D3)

Note 59: This flag, by its value of 1, indicates an event of detection of at least one synchronization pulse since its last reset (by means of the SDetReset I²C-bus bit). This is to be taken into account by application S/W in a way that enough time (at least the period between 2 synchronization pulses of analyzed signal) must be provided between reset of the flag through SDetReset bit and validation of information provided in the flag after read-out of status register.

9 OPERATING DESCRIPTION

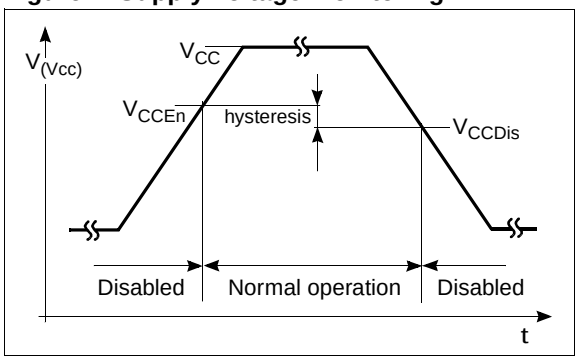
9.1 Supply and control

9.1.1 Power supply and voltage references

The device is designed for a typical value of power supply voltage of 12 V.

In order to avoid erratic operation of the circuit at power supply ramp-up or ramp-down, the value of V_{CC} is monitored. See Figure 1 and electrical specifications. At switch-on, the device enters a “normal operation” as the supply voltage exceeds V_{CCEn} and stays there until it decreases bellow V_{CCDis}. The two thresholds provide, by their difference, a hysteresis to bridge potential noise. Outside the “normal operation”, the signals on HOut, BOut and VOut outputs are inhibited and the I²C-bus interface is inactive (high impedance on SDA, SCL pins, no ACK), all I²C-bus control registers being reset to their default values (see Chapter 8 - page 25). The stop of HOut and BOut drive signals when the V_{CC} falls from normal operation below V_{CCDis} is not instantaneous. It is only a trigger point of Soft Stop mechanism (see Subsection 9.3.7- page 35).

Figure 1. Supply voltage monitoring



Internal thresholds in all parts of the circuit are derived from a common internal reference supply V_{RefO} that is lead out to RefOut pin for external filtering against ground as well as for external use with load currents limited to I_{RefO}. The filtering is necessary to minimize interference in output signals, causing adverse effects like e.g. jitter.

9.1.2 I²C-bus control

The I²C-bus is a 2 line bidirectional serial communication bus introduced by Philips. For its general description, refer to corresponding Philips I²C-bus specification.

This device is an I²C-bus slave, compatible with fast (400kHz) I²C-bus protocol, with write mode slave address of 8Ch (read mode slave address 8Dh). Integrators are employed at the SCL (Serial Clock) input and at the input buffer of the SDA (Serial Data) input/output to filter off the spikes up to 50ns.

The device supports multiple data byte messages (with automatic incrementing of the I²C-bus subaddress) as well as repeated Start Condition for I²C-bus subaddress change inside the I²C-bus messages. All I²C-bus registers with specified I²C-bus subaddress are of WRITE ONLY type, whereas the status register providing a feedback information to the master I²C-bus device has no attributed I²C-bus subaddress and is of READ ONLY type. The master I²C-bus device reads this register sending directly, after the Start Condition, the READ device I²C-bus slave address (8Dh) followed by the register read-out, NAK (No Acknowledge) signal and the Stop Condition.

For the I²C-bus control register map, refer to Chapter 8 - page 25.

9.2 Synchronization processor

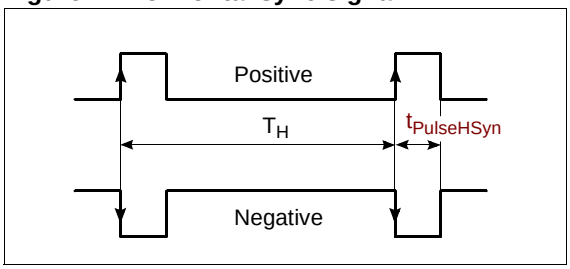
9.2.1 Synchronization signals

The device has two inputs for TTL-level synchronization signals, both with hysteresis to avoid erratic detection and with a pull-down resistor. On H/HVSyn input, pure horizontal or composite horizontal/vertical signal is accepted. On VSyn input, only pure vertical sync. signal is accepted. Both positive and negative polarities may be applied on either input, see Figure 2. Polarity detector and programmable inverter are provided on each of the two inputs. The signal applied on H/HVSyn pin, after polarity treatment, is directly lead to horizontal part and to an extractor of vertical sync. pulses, working on principle of integration, see Figure 3. The vertical sync. signal applied to the vertical deflection processor is selected between the signal extracted from the composite signal on H/HVSyn input and the one applied on VSyn input. The selector is controlled by VSyncSel I²C-bus bit.

Besides polarity detection, the device is capable of detecting presence of sync. signals on each of the inputs and at the output of vertical sync. extractor. The information from all detectors is provided in the I²C-bus status register (5 flags: VDet, HVDet,

VExtrDet, VPol, HVPol). The device is equipped with an automatic mode (switched on or off by VSyncAuto I²C-bus bit) that also uses the detection information.

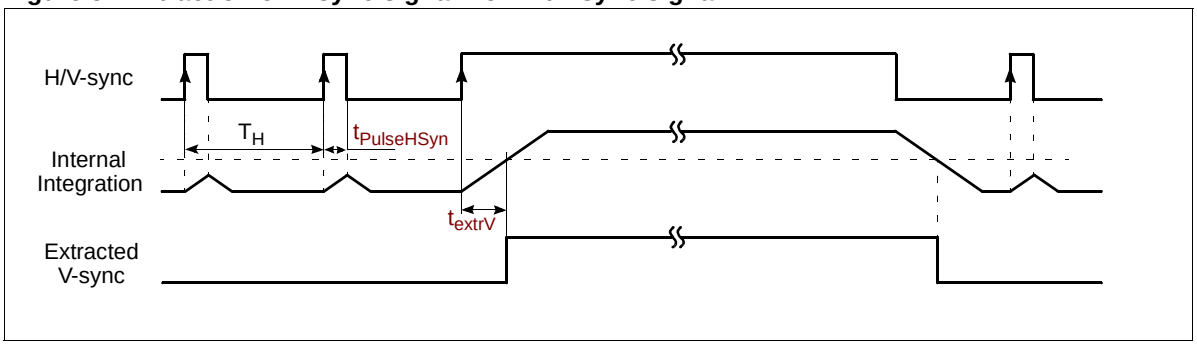
Figure 2. Horizontal sync signal



9.2.2 Sync. presence detection flags

The sync. signal presence detection flags in the status register (VDet, HVDet, VExtrDet) do not show in real time the presence or absence of corresponding sync. signal. They are latched to 1 as soon as a single sync. pulse is detected. In order to reset them to 0 (all at once), a 1 must be written into SDetReset I²C-bus bit, the reset action taking effect with ACK bit of the I²C-bus transfer to the register containing SDetReset bit. The detection circuits are ready to capture another event (pulse). See Note 59.

Figure 3. Extraction of V-sync signal from H/V-sync signal



9.2.3 MCU controlled sync. selection mode

I²C-bus bit VSyncAuto is set to 0. The MCU reads the polarity and signal presence detection flags, after setting the SDetReset bit to 1 and an appropriate delay, to obtain a true information of the signals applied, reads and evaluates this information and controls the vertical signal selector accordingly. The MCU has no access to polarity inverters, they are controlled automatically.

See also chapter Chapter 8 - page 25.

9.2.4 Automatic sync. selection mode

I²C-bus bit VSyncAuto is set to 1. In this mode, the device itself controls the I²C-bus bits switching the polarity inverters (HVPol, VPol) and the vertical sync. signal selector (VSyncSel), using the information provided by the detection circuitry. If both extracted and pure vertical sync. signals are present, the one already selected is maintained. No intervention of the MCU is necessary.

9.3 Horizontal section

9.3.1 General

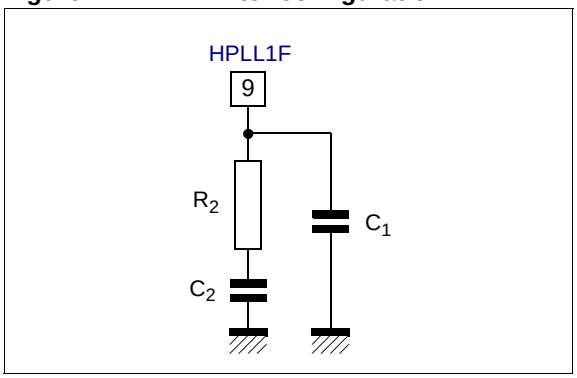
The horizontal section consists of two PLLs with various adjustments and corrections, working on horizontal deflection frequency, then phase shifting and output driving circuitry providing H-drive signal on HOut pin. Input signal to the horizontal section is output of the polarity inverter on H/HVSyn input. The device ensures automatically that this polarity be always positive.

9.3.2 PLL1

The PLL1 block diagram is in Figure 5. It consists of a voltage-controlled oscillator (VCO), a shaper with adjustable threshold, a charge pump with inhibition circuit, a frequency and phase comparator and timing circuitry. The goal of the PLL1 is to make the VCO ramp signal match in frequency the sync. signal and to lock this ramp in phase to the sync. signal. On the screen, this offset results in the change of horizontal position of the picture. The loop, by tuning the VCO accordingly, gets and maintains in coincidence the rising edge of input sync. signal with signal REF1, deriving from the VCO ramp by a comparator with threshold adjustable through ***HPOS*** I²C-bus control. The coincidence is identified and flagged by lock detection circuit on pin HLckVBk as well as by HLock I²C-bus flag.

The charge pump provides positive and negative currents charging the external loop filter on HPLL1F pin. The loop is independent of the trailing edge of sync. signal and only locks to its leading edge. By design, the PLL1 does not suffer from any dead band even while locked. The speed of the PLL1 depends on current value provided by the charge pump. While not locked, the current is very low, to slow down the changes of VCO frequency and thus protect the external power components at sync. signal change. In locked state, the currents are much higher, four different values being selectable via PLL1Pump I²C-bus bits to provide a means to control the PLL1 speed by S/W. Lower value make the PLL1 slower, but more stable. Higher values make it faster and less stable. In general, the PLL1 speed should be higher for high deflection frequencies. The response speed and stability (jitter level) depend on the choice of external components making up the loop filter. A “CRC” filter is generally used (see Figure 4).

Figure 4. H-PLL1 filter configuration



The PLL1 is internally inhibited during extracted vertical sync. pulse (if any) to avoid taking into account missing or wrong pulses on the phase comparator. Inhibition is obtained by forcing the charge pump output to high impedance state. The inhibition mechanism can be disabled through PLL1InhEn I²C-bus bit.

The Figure 7, in its upper part, shows the position of the VCO ramp signal in relation to input sync. pulse for three different positions of adjustment of horizontal position control ***HPOS***.

Figure 5. Horizontal PLL1 block diagram

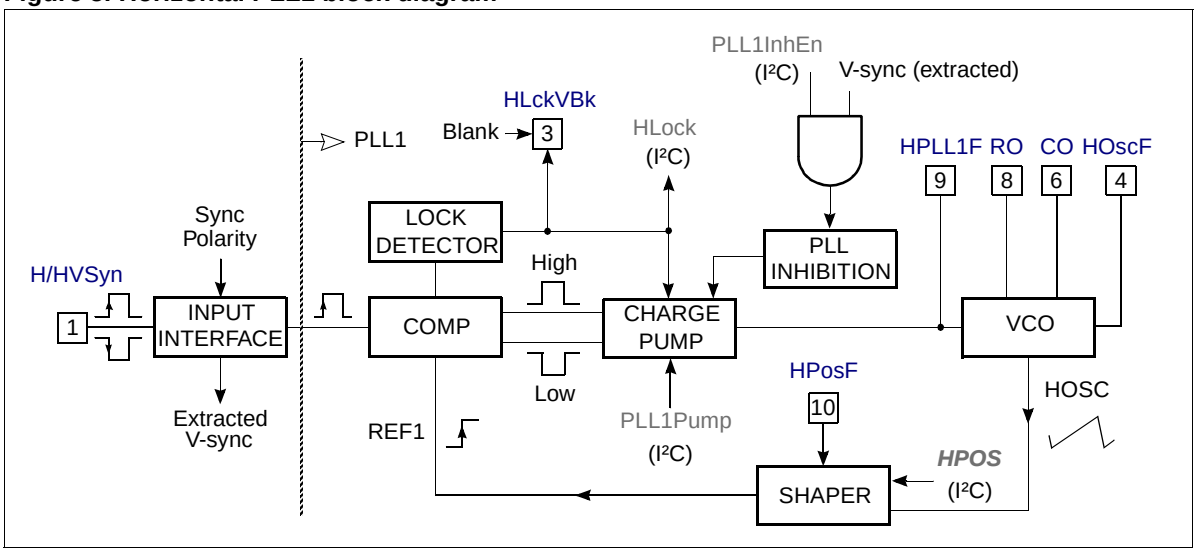
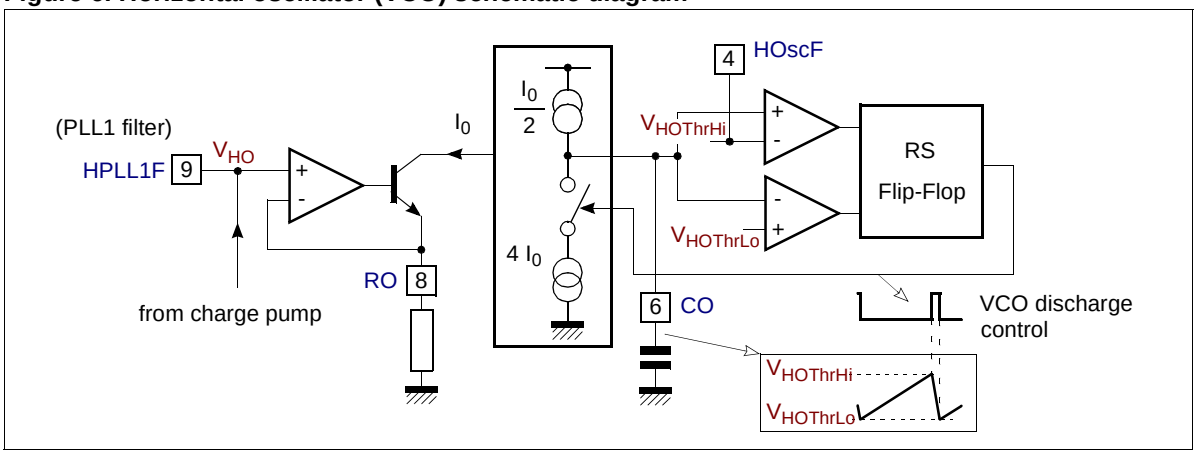


Figure 6. Horizontal oscillator (VCO) schematic diagram



9.3.3 Voltage controlled oscillator

The VCO makes part of both PLL1 and PLL2 loops, being an “output” to PLL1 and “input” to PLL2. It delivers a linear sawtooth. Figure 6 explains its principle of operation. The linears are obtained by charging and discharging an external capacitor on pin CO, with currents proportional to the current forced through an external resistor on pin RO, which itself depends on the input tuning voltage V_{HO} (filtered charge pump output). The rising and falling linears are limited by $V_{HOThrLo}$ and $V_{HOThrHi}$ thresholds filtered through HOscF pin.

At no signal condition, the V_{HO} tuning voltage is clamped to its minimum (see section 6.4 - page 10), which corresponds to the free-running VCO frequency $f_{HO(0)}$. Refer to subsection 9.3.1 for formula to calculate this frequency using external components values. The ratio between the frequency corresponding to maximum V_{HO} and the one corresponding to minimum V_{HO} (free-running frequency) is about 4.5. This range can easily be increased in the application. The PLL1 can only lock to input frequencies falling inside these two limits.

9.3.4 PLL2

The goal of the PLL2 is, by means of phasing the signal driving the power deflection transistor, to lock the middle of the horizontal flyback to a certain threshold of the VCO sawtooth. This internal threshold is affected by geometry phase corrections, like e.g., parallelogram. The PLL2 is fast enough to be able to follow the dynamism of phase modulation, this speed is strongly related to the value of the capacitor on HPLL2C. The PLL2 control current (see Figure 7) is significantly increased during discharge of vertical oscillator (during vertical retrace period) to be able to make up for the difference of dynamic phase at the bottom and at the top of the picture. The PLL2 control current is integrated on the external filter on pin HPLL2C to obtain smoothed voltage, used, in comparison with VCO ramp, as a threshold for H-drive rising edge generation.

As both leading and trailing edges of the H-drive signal in the Figure 7 must fall inside the rising part of the VCO ramp, an optimum middle position of the threshold has been found to provide enough margin for horizontal output transistor storage time as well as for the trailing edge of H-drive signal with maximum duty cycle. Yet, the constraints thereof must be taken into account while considering the application frequency range and H-flyback duration. The Figure 7 also shows regions for rising and falling edges of the H-drive signal on HOut pin. As it is forced high during the H-flyback pulse and low during the VCO discharge period, no edge during these two events takes effect.

The flyback input configuration is in Figure 8.

9.3.5 Dynamic PLL2 phase control

The dynamic phase control of PLL2 is used to compensate for picture asymmetry versus vertical axis across the middle of the picture. It is done by modulating the phase of the horizontal deflection with respect to the incoming video (synchronization). Inside the device, the threshold $V_{S(0)}$ is compared with the VCO ramp, the PLL2 locking the middle of H-flyback to the moment of their match. The dynamic phase is obtained by modulation of the threshold by correction waveforms. Refer to Figure 14 and Chapter 7 - page 21. The correction waveforms have no effect in vertical middle of the screen (for middle vertical position). As they are summed, their effect on the phase tends to reach maximum span at top and bottom of the picture. As all the components of the resulting correction waveform (linear for parallelogram correction, parabola of 2nd order for Pin cushion asymmetry correction and half-parabolas of 4th order for corner corrections independently at the top and at the bottom) are generated from the output vertical deflection drive waveform, they all track with real vertical amplitude and position, thus being fixed on the screen. Refer to Chapter 8 - page 25 for details on I²C-bus controls.

Figure 7. Horizontal timing diagram

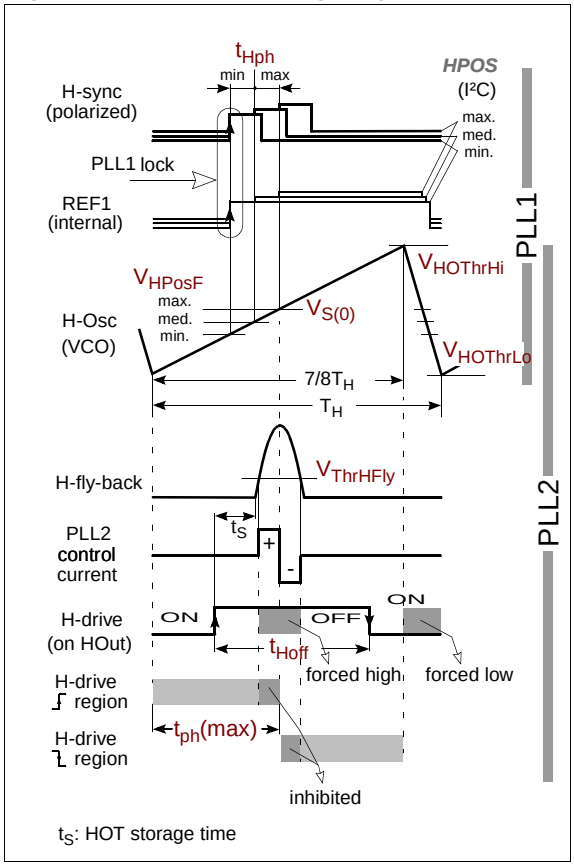
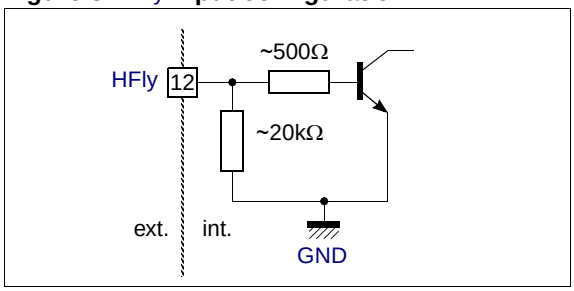


Figure 8. HFly **input configuration**



9.3.6 Output Section

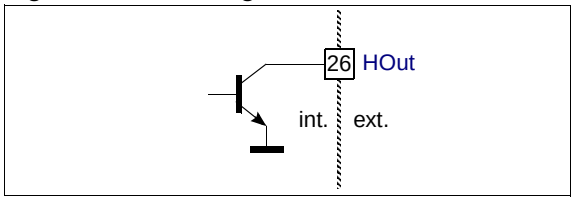
The H-drive signal is inhibited (high level) during flyback pulse, and also when V_{CC} is too low, when X-ray protection is activated (XRayAlarm I²C-bus flag set to 1) and when I²C-bus bit HBOutEn is set to 0 (default position).

The duty cycle of the H-drive signal is controlled via I²C-bus register ***HDUTY***. This is overruled during soft-start and soft-stop procedures (see Section 9.3.7 and Figure 10).

The PLL2 is followed by a rapid phase shifting which accepts the signal from H-moiré canceller (see Section 9.3.8)

The output stage consists of a NPN bipolar transistor, the collector of which is routed to HOut pin (see Figure 9).

Figure 9. HOut **configuration**



9.3.7 Soft-start and soft-stop on H-drive

The soft-start and soft-stop procedure is carried out at each switch-on or switch-off of the H-drive signal, either via HBOutEn I²C-bus bit or after reset of XRayAlarm I²C-bus flag, to protect external power components. By its second function, the external capacitor on pin HPosF is used to time out this procedure, during which the duty cycle of H-drive signal starts at its maximum (t_{Hoff} for soft start/stop in electrical specifications) and slowly decreases to the value determined by the control I²C-bus register ***HDUTY*** (vice versa at soft-stop). This is controlled by voltage on pin HPosF. In case of supply voltage switch off, the transients on HOut and BOut have different characteristics. See Figure 10, Figure 11 and Section 9.8.1.

9.3.8 Horizontal moiré cancellation

The horizontal moiré canceller is intended to blur a potential beat between the horizontal video pixel period and the CRT pixel width, which causes visible moiré patterns in the picture.

It introduces a microscopic indent on horizontal scan lines by injecting little controlled phase shifts to output circuitry of the horizontal section. Their amplitude is adjustable through ***HMOIRE*** I²C-bus control.

The behaviour of horizontal moiré is to be optimized for different deflection design configurations using HMoiréMode I²C-bus bit. This bit is to be kept at 0 for common architecture (B+ and EHT common regulation) and at 1 for separated architecture (B+ and EHT each regulated separately). The maximum amplitude adjustable though ***HMOIRE*** I²C-bus control is optimized according to selection by HMoiréMode I²C-bus bit: larger when B+ and EHT are each regulated separately, smaller when B+ and EHT are common regulation.

Figure 10. Control of HOut and BOut at start/stop at nominal V_{CC}

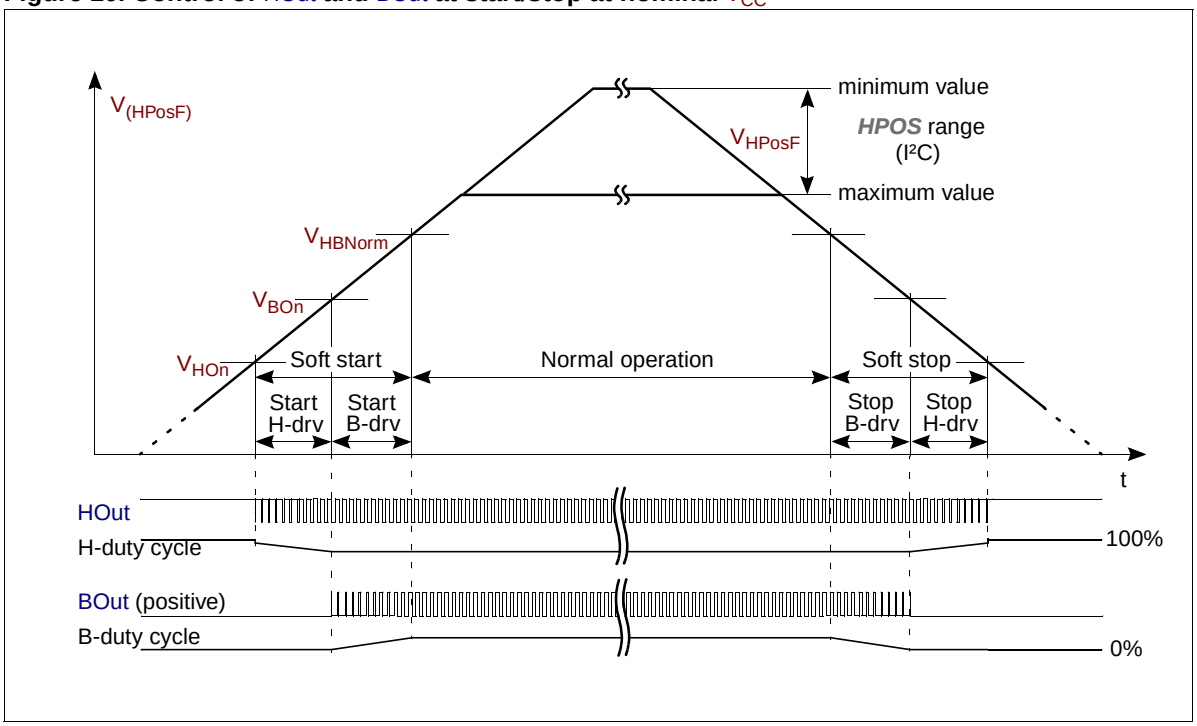
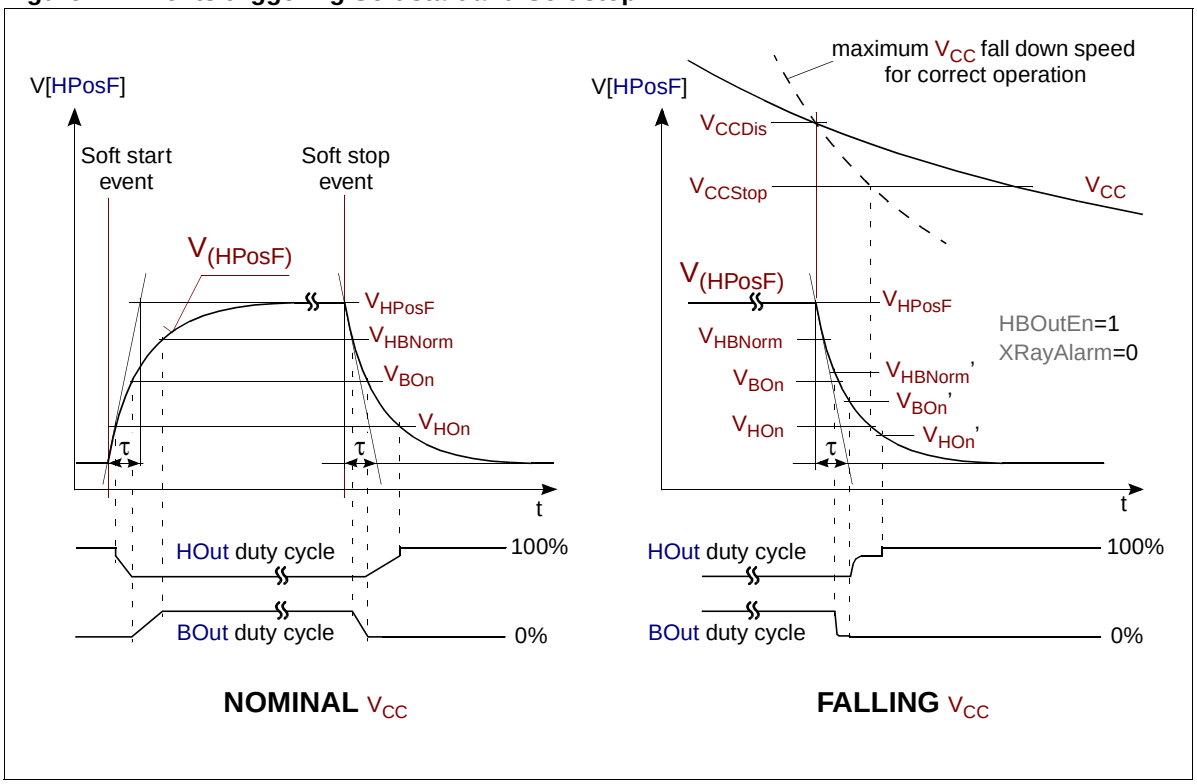


Figure 11. Events triggering Soft start and Soft stop



9.4 Vertical section

9.4.1 General

The goal of the vertical section is to drive vertical deflection output stage. It delivers a sawtooth waveform with an amplitude independent of deflection frequency, on which vertical linearity corrections of C- and S-type are superimposed (see Chapter 7 - page 21).

Block diagram is in Figure 12. The sawtooth is obtained by charging an external capacitor on pin VCap with controlled current and by discharging it via transistor Q1. This is controlled by the CONTROLLER. The charging starts when the voltage across the capacitor drops below V_{VOB} threshold. The discharging starts either when it exceeds V_{VOT} threshold (free run mode) or a short time after arrival of synchronization pulse. This time is necessary for the AGC loop to sample the voltage at the top of the sawtooth. The V_{VOB} reference is routed out onto VOscF pin in order to allow for further filtration.

The charging current influences amplitude of the sawtooth. Just before the discharge, the voltage across the capacitor on pin VCap is sampled and compared to V_{VOTref}. The comparison error voltage is stored on a storage capacitor connected on pin VAGCCap. This voltage tunes gain of the transconductance amplifier providing the charging current in the next vertical period. Speed of this AGC loop depends on the storage capacitance on pin VAGCCap. The VLock I²C-bus flag is set to 1 when the loop is stabilized, i.e. when the tops of saw tooth on pin VCap match V_{VOT} value. On the screen, this corresponds to stabilized vertical size of picture. After a change of frequency on the sync. input, the stabilization time depends on the frequency difference and on the capacitor value. The lower its value, the shorter the stabilization time, but on the other hand, the lower the loop stability. A practical compromise is a capacitance of 470nF. The leakage current of this capacitor results in difference in amplitude between low and high frequencies. The higher its parallel resistance $R_{L(VAGCCap)}$, the lower this difference.

When the synchronization pulse is not present, the charging current is fixed. As a consequence, the free-running frequency $f_{VO(0)}$ only depends on the value of the capacitor on pin VCap. It can be roughly calculated using the following formula

$$f_{VO(0)} = \frac{150nF}{C_{(VCap)}} \cdot 100Hz$$

The frequency range in which the AGC loop can regulate the amplitude also depends on this capacitor.

The vertical sawtooth with regulated amplitude is lead to amplitude control stage. The discharge exponential is replaced by V_{VOB} level, which, under control of the CONTROLLER, creates a rapid falling edge and a flat part before beginning of new ramp.

The AGC output signal passes through gain and position adjustment stages controlled through ***VSIZE*** and ***VPOS*** I²C-bus registers. The resulting signal serves as input to all geometry correction circuitry including EW-drive signal, horizontal phase modulation and dynamic correction outputs.

9.4.2 S and C corrections

For the sake of vertical picture linearity, the S- and C-corrections are now superimposed on the linear ramp signal. They both track with ***VSIZE*** and ***VPOS*** adjustments to ensure unchanged linearity on the screen at changes of vertical size or vertical position. As these corrections are not included in the AGC loop, their adjustment via ***CCOR*** and ***SCOR*** I²C-bus registers, controlling shape of vertical output sawtooth affects by principle its peak-to-peak amplitude. However, this stage is conceived in a way that the amplitude be independent of these adjustments if ***VSIZE*** and ***VPOS*** registers are set to their medium values.

9.4.3 Vertical breathing compensation

The signal provided with the linearity corrections is amplitude affected in a gain control stage, ruled by the voltage on VEHTIn input and its I²C-bus control ***VEHTG***.

9.4.4 Vertical after-gain and offset control

Another gain control is applied via ***VSAG*** I²C-bus register. Then an offset is added, its amount corresponding to ***VPOF*** I²C-bus register value. These two controls result in size and position changes with no effect on shape of output vertical sawtooth or any geometry correction signal.

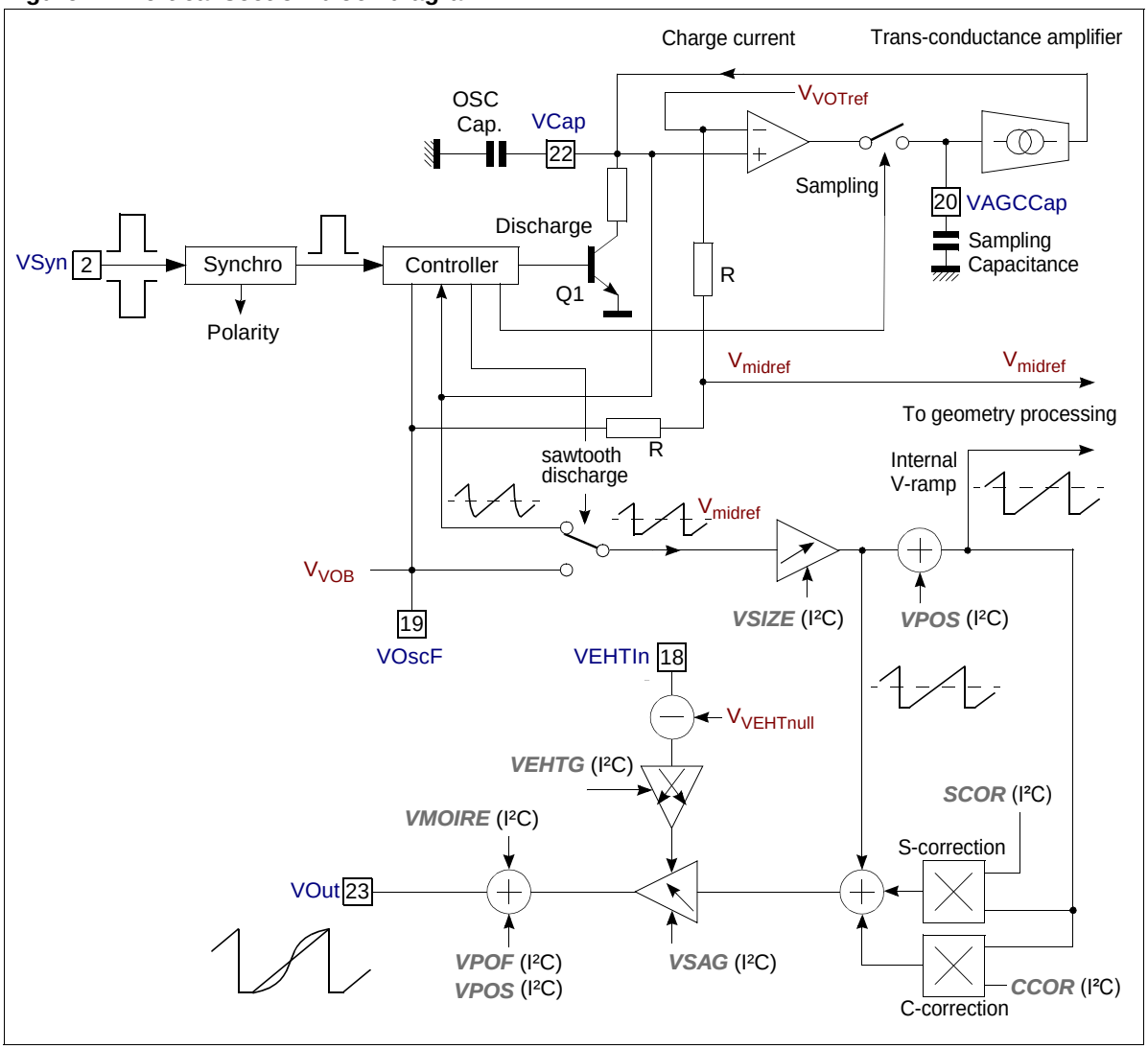
9.4.5 Vertical moiré

To blur potential moiré patterns due to interaction of deflection lines with CRT mask grid, the picture position is to be slightly alternated at frame frequency. For this purpose, a square waveform at half-frame frequency is superimposed on the output waveform. Its amplitude is adjustable through ***VMOIRE*** I²C-bus control.

9.4.6 Biasing of vertical booster

The biasing voltage for external DC-coupled vertical power amplifier is to be derived from V_{RefO} voltage provided on pin RefOut, using a resistor divider, this to ensure the same temperature drift of mean (DC) levels on both differential inputs and to compensate for spread of V_{RefO} value (and so mean output value) between particular devices.

Figure 12. Vertical section block diagram



9.5 EW drive section

The goal of the EW drive section is to provide, on pin EWOut, a waveform which, used by an external DC-coupled power stage, serves to compensate for those geometry errors of the picture that are symmetric versus vertical axis across the middle of the screen.

The waveform consists of an adjustable DC value, corresponding to horizontal size, a parabola of 2nd order for “pin cushion” correction, a linear for “keystone” correction, independent half-parabolas of 4th order for top and bottom corner corrections, S-shape for “S” correction and W shape for “W” correction. All of them are adjustable via I²C-bus, see Chapter 8 - page 25.

Refer to Figure 14, Figure 15 and chapter Chapter 7 - page 21. The adjustments of these correction waveforms have no effect in the middle of the vertical scan period (if the ***VPOS*** control is adjusted to its medium value). As they are summed, the resulting waveform tends to reach its maximum span at top and bottom of the picture. The voltage at the EWOut is top and bottom limited (see parameter V_{EW}). According to Figure 15, especially the bottom limitation seems to be critical for maximum horizontal size (minimum DC). Actually it is not critical since the parabola component must always be applied to obtain a picture without pin cushion distortion. As all the components of the resulting correction waveform are generated from an internal linear vertical sawtooth waveform bearing ***VSIZE*** and ***VPOS*** adjustments, they all track with vertical amplitude and position, thus being fixed vertically on the screen. They are not affected by C- and S-corrections, by prescale adjustments (***VSAG*** and ***VPOF***), by vertical breathing compensation and by vertical moire cancellation. The sum of components other than DC is conditionally affected by value in ***HSIZE*** I²C-bus control in reversed sense. Refer to electrical specifications for value. This tracking with ***HSIZE*** can be switched off by EWTrHSize I²C-bus bit. The DC value, adjusted via ***HSIZE*** control, is also affected by voltage on HEHTIn input, thus providing a horizontal breathing compensation. The effect of this compensation is controlled by ***HEHTG***. The resulting waveform is conditionally multiplied with voltage on HPLL1F, which depends on frequency. Refer to electrical specifications for values. This tracking with frequency provides a rough compensation of variation of picture geometry with frequency and allows to fix the adjustment ranges of I²C-bus controls throughout the operating range of horizontal frequencies. It can be switched off by EWTrHFr I²C-bus bit (off by default). The functionality is explained in Figure 13. The upper part gives the influence on DC component, the lower part on AC component, showing also the tracking with ***HSIZE***. Grey zones give the total span of breathing correction using the whole range of input operating voltage on HEHTIn input and whole range of adjustment of ***HEHTG*** register.

The EW waveform signal is buffered by an NPN emitter follower, the emitter of which is directly routed to EWOut output. It is internally biased (see electrical specifications for current value).

Figure 13. Tracking of EWOut signal with frequency

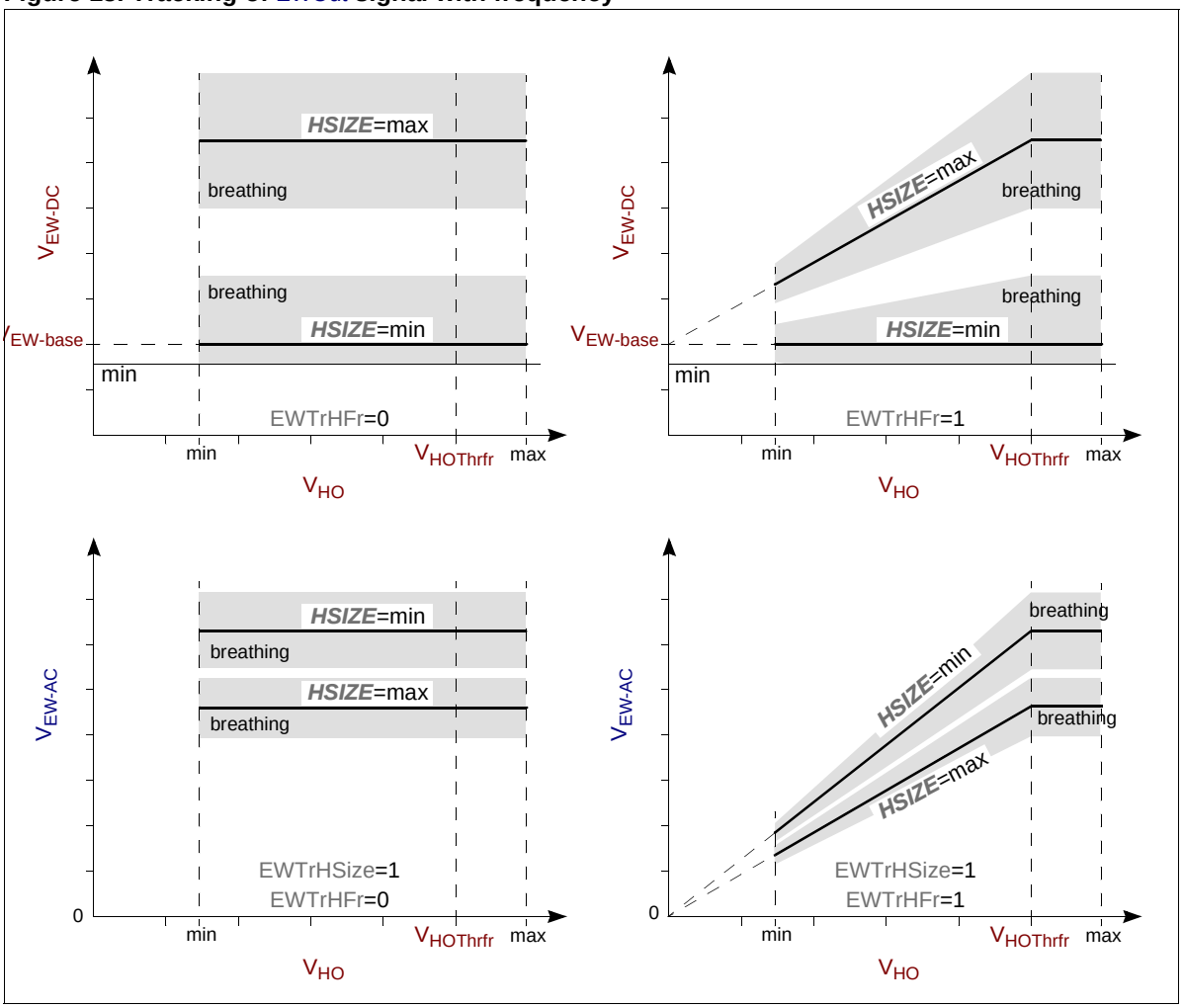


Figure 14. Geometric corrections' schematic diagram

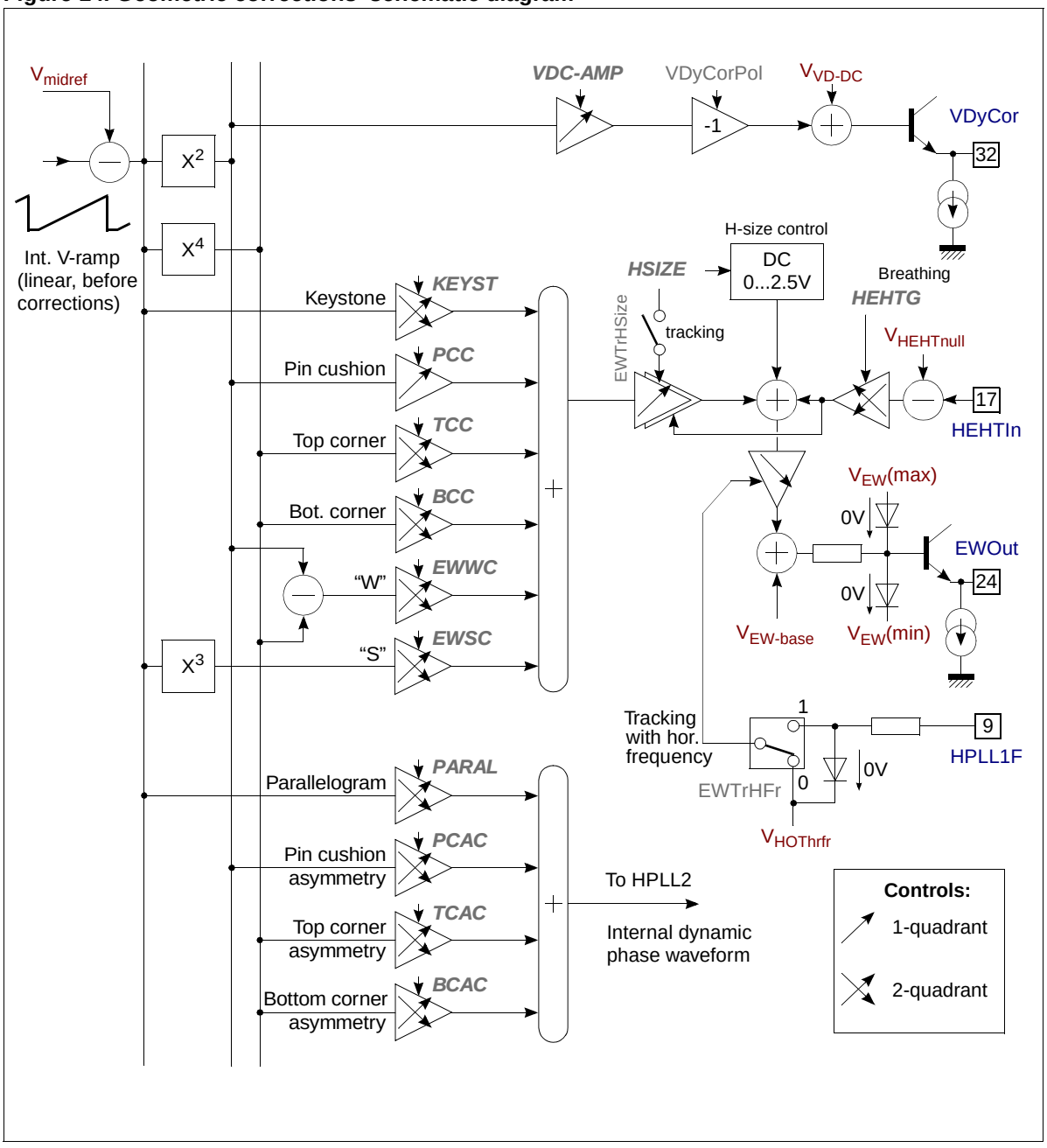
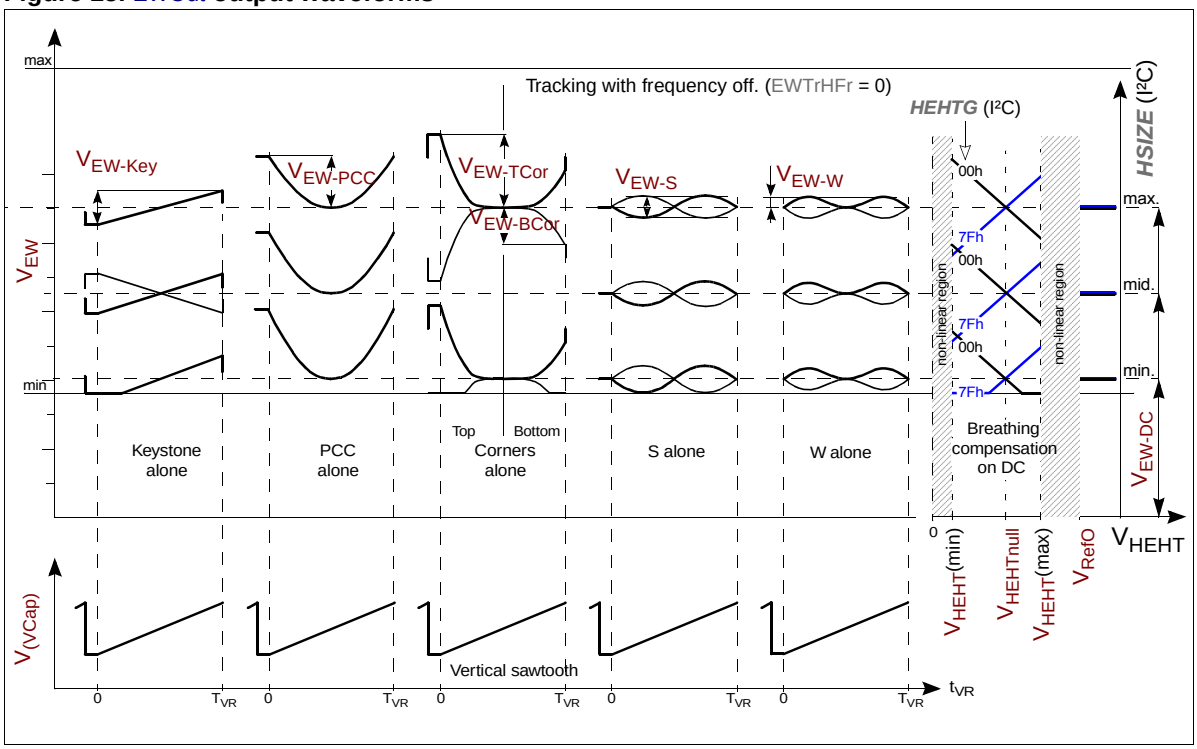


Figure 15. EWOut **output waveforms**



9.6 Dynamic correction outputs section

9.6.1 Vertical dynamic correction output VDyCor

A parabola at vertical deflection frequency is available on pin VDyCor. Its amplitude is adjustable via ***VDC-AMP*** I²C-bus control and polarity controlled via VDyCorPol I²C-bus bit. It tracks with real vertical amplitude and position. It is not affected by C- and S-corrections or breathing compensation. It does not track with ***Vertical size after-gain*** (Sad1Dh) nor with ***Vertical position offset*** (Sad1Eh) adjustments.

The use of both correction waveforms is up to the application (e.g. dynamic focus, dynamic brightness control).

9.7 DC/DC controller section

The section is designed to control a switch-mode DC/DC converter. A switch-mode DC/DC convertor generates a DC voltage from a DC voltage of different value (higher or lower) with little power losses. The DC/DC controller is synchronized to horizontal deflection frequency to minimize potential interference into the picture.

Its operation is similar to that of standard UC3842.

The schematic diagram of the DC/DC controller is in Figure 16. The BOut output controls an external switching circuit (a MOS transistor) delivering pulses synchronized on horizontal deflection frequency, the phase of which depends on H/W and I²C-bus configuration. See the table at the end of this chapter. Their duration depends on the feedback provided to the circuit, generally a copy of DC/DC converter output voltage and a copy of current passing through the DC/DC converter circuitry (e.g. current through external power component). The polarity of the output can be controlled by BOutPol I²C-bus bit. A NPN transistor open-collector is routed out to the BOut pin.

During the operation, a sawtooth is to be found on pin BISense, generated externally by the application. According to BOutPh I²C-bus bit, the R-S flip-flop is set either at H-drive signal edge (rising or falling, depending on BOHEdge I²C-bus bit), or a certain delay ($t_{BTrigDel}$) after middle of H-flyback, or at horizontal frequency divided by two (phase corresponding to $V_{HOThrHi}$ on the VCO ramp). The output is set On at the end of the short pulse generated by the monostable trigger.

Timing of reset of the R-S flip-flop affects duty cycle of the output square signal and so the energy transferred from DC/DC converter input to its output. A reset edge is provided by comparator C2 if the voltage on pin BISense exceeds the internal threshold $V_{ThrBIsCurr}$. This represents current limitation if a voltage proportional to the current through the power component or deflection stage is available on pin BISense. This threshold is affected by voltage on pin HPosF, which rises at soft start and descends at soft stop. This ensures self-contained soft control of duty cycle of the output signal on pin BOut. Refer to Figure 10. Another condition for reset of the R-S flip-flop, OR-ed with the one described before, is that the voltage on pin BISense exceeds the voltage V_{C2}, which depends on the voltage applied on input BRegIn of the error amplifier O1. The two voltages are compared, and the reset signal generated by the comparator C1. The error amplifier amplifies (with a factor defined by external components) the difference between the input voltage proportional to DC/DC convertor output voltage and internal reference V_{BReg}. The internal reference and so the output voltage is I²C-bus adjustable by means of ***BREF*** I²C-bus control.

Both step-up (DC/DC converter output voltage higher than its input voltage) and step-down (output voltage lower than input) can be built.

9.7.1 Synchronization of DC/DC controller

For sake of application flexibility, the output drive signal on BOut pin can be synchronized with one of four events in Table 9. For the first line case, the synchronization instant is every second top of horizontal VCO saw tooth. See Figure 7.

9.7.2 Soft-start and soft-stop on B-drive

The soft-start and soft-stop procedure is carried out at each switch-on or switch-off of the B-drive signal, either via HBOutEn I²C-bus bit or after reset of XRayAlarm I²C-bus flag, to protect external power component. See Figure 10 and sub chapter Safety functions on page 45.

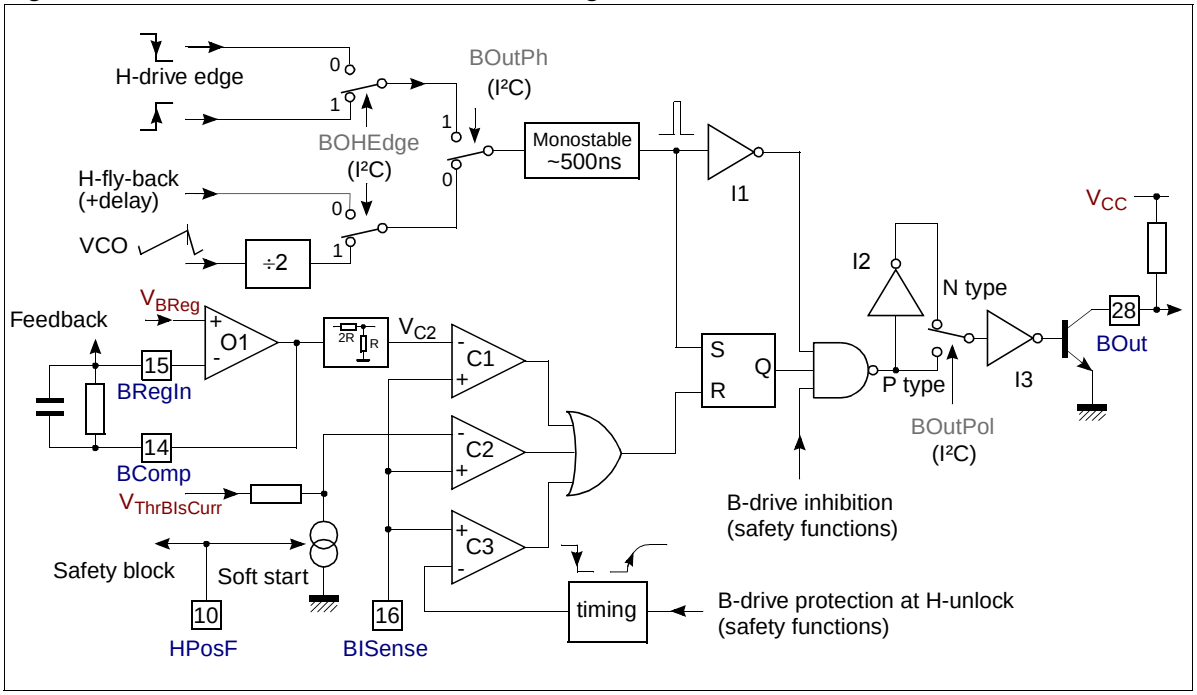
The drive signal on BOut pin can be switched off alone by means of BMute I²C-bus bit, without switching off the drive signal on pin HOut. The switch-off is quasi-immediate, without the soft-stop procedure. At switching back on, the soft-start of the DC/DC controller is performed, timed by an internal timing circuit, see Figure 16.

When BSafeEn I²C-bus bit is enabled, the drive signal on BOut pin will go off as soon as the horizontal PLL1 indicates unlocked state, without the soft-stop. Resuming of locked state will initiate the soft-start mechanism of the DC/DC controller, timed by an internal timing circuit.

Table 9. IDC/DC controller Off-to-On edge timing

BOutPh (Sad07h/D7)	BOHEdge (Sad17h/D3)	Timing of Off-to-On transition on BOut output
0	1	VCO ramp top at Horizontal frequency divided by two
0	0	Middle of H-flyback plus $t_{BTrigDel}$
1	0	Falling edge of H-drive signal
1	1	Rising edge of H-drive signal

Figure 16. DC/DC converter controller block diagram



9.8 Miscellaneous

9.8.1 Safety functions

The safety functions comprise supply voltage monitoring with appropriate actions, soft start and soft stop features on H-drive and B-drive signals on HOut and BOut outputs, B-drive cut-off at unlock condition and X-ray protection.

For supply voltage supervision, refer to subsection 9.1.1 and Figure 1. A schematic diagram putting together all safety functions and composite PLL1 lock and V-blanking indication is in Figure 17.

9.8.1.1 Soft start and soft stop function

For soft start and soft stop features for H-drive and B-drive signal, refer to subsection 9.3.7 and subsection 9.7 , respectively. See also the Figure 10 and Figure 11. Regardless why the H-drive or B-drive signal are switched on or off (I²C-bus command, power up or down, X-ray protection), the signals always phase-in and phase-out in the way drawn in the figures, the first to phase-in and last to phase-out being the H-drive signal, which is to better protect the power stages at abrupt changes like switch-on and off. The timing of phase-in and phase-out depends on the capacitance connected to HPosF pin which is virtually unlimited for this function. However, as it has a dual function (see subsection 9.3.2), a compromise thereof is to be found.

The soft stop at power down condition can be considered as a special case. As at this condition the thresholds V_{HOn}, V_{BOn} and V_{HBNorm} depend on the momentary level of supply voltage (marked V_{HOn}', V_{BOn}', V_{HBNorm}' in Figure 11), the timing of soft stop mechanism depends, apart from the capacitance on HPosF, also on the falling speed of supply voltage. The device is capable of performing a correct soft stop sequence providing that, at the moment the supply voltage reaches V_{CCStop}, the voltage on HPosF has already fallen below V_{HOn} (Section 9.8).

9.8.1.2 B-drive cut-off at unlock condition

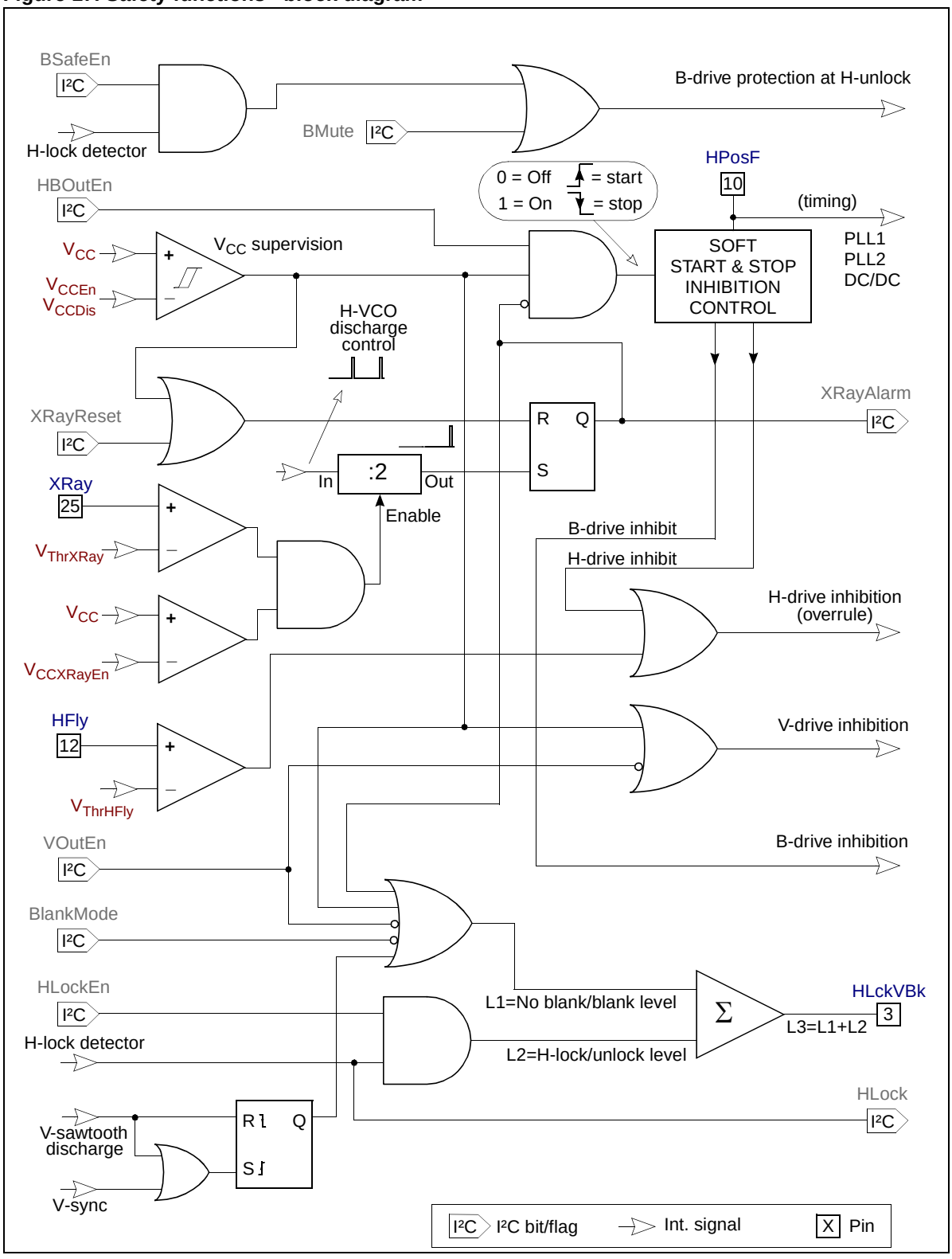
This function is described in subsection 9.7.2 .

9.8.1.3 X-ray protection

The X-ray protection is activated if the voltage level on XRay input exceeds $V_{ThrXRay}$ threshold and if the V_{CC} is higher than the voltage level $V_{CCXRayEn}$. As a consequence, the H-drive and B-drive signals on HOut and BOut outputs are inhibited (switched off) after a 2-horizontal deflection line delay provided to avoid erratic excessive X-ray condition detection at short parasitic spikes. The XRayAlarm I²C-bus flag is set to 1 to inform the MCU.

This protection is latched; it may be reset either by V_{CC} drop or by I²C-bus bit XRayReset
(see Chapter 8 - page 25).

Figure 17. Safety functions - block diagram

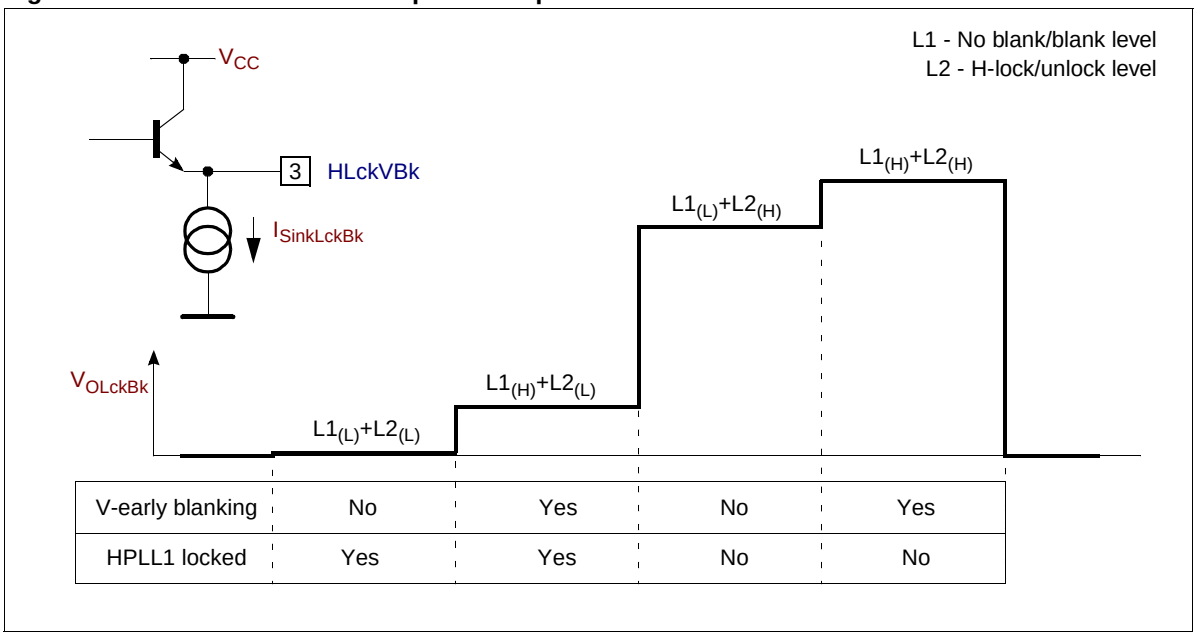


9.8.2 Composite output HLckVBk

The composite output HLckVBk provides, at the same time, information about lock state of PLL1 and early vertical blanking pulse. As both signals have two logical levels, a four level signal is used to define the combination of the two. Schematic diagram putting together all safety functions and composite PLL1 lock and V-blanking indication is in Figure 17, the combinations, their respective levels and the HLckVBk configuration in Figure 18.

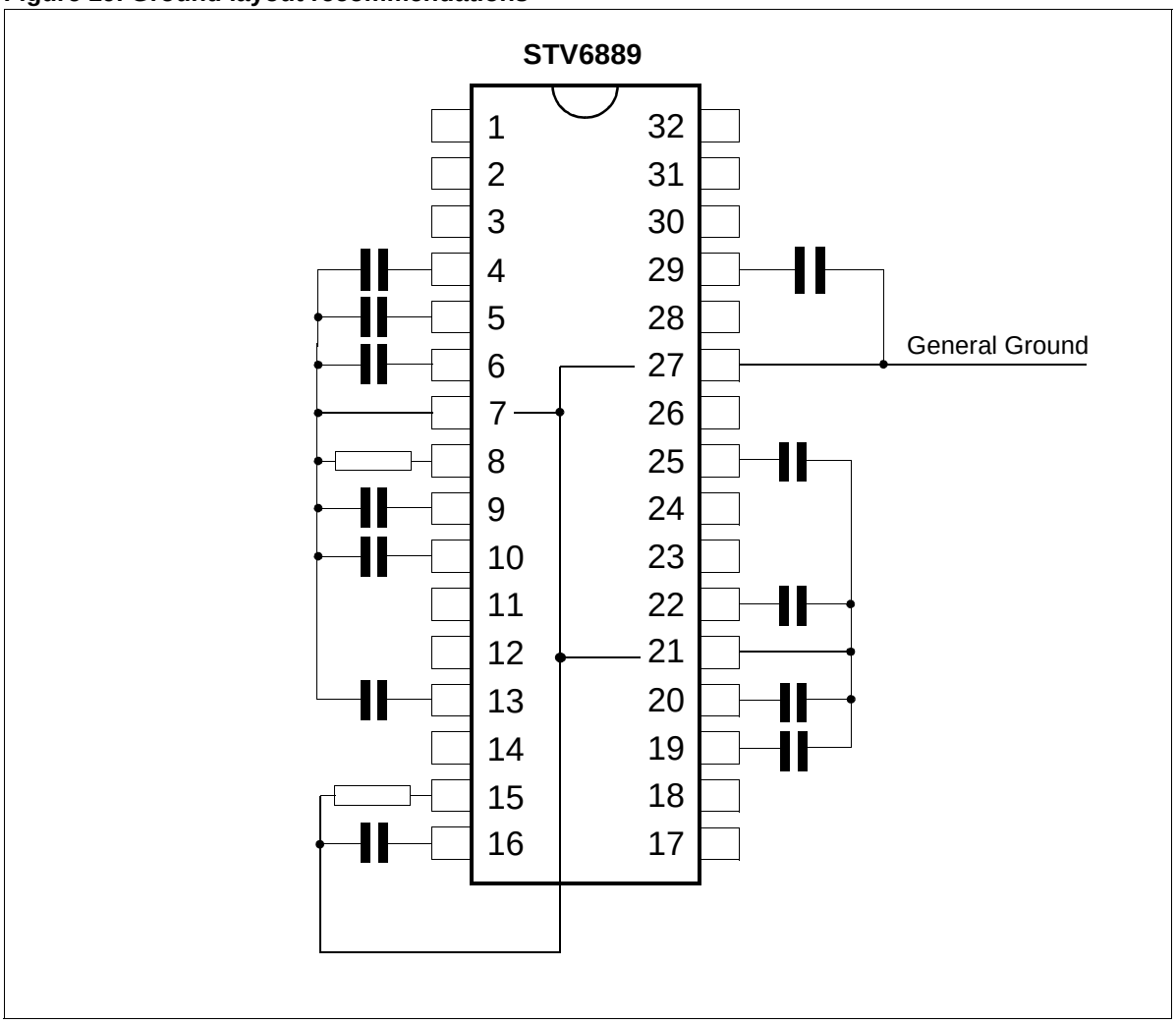
The early vertical blanking pulse is obtained by a logic combination of vertical synchronization pulse and pulse corresponding to vertical oscillator discharge. The combination corresponds to the drawing in Figure 18. The blanking pulse is started with the leading edge of any of the two signals, whichever comes first. The blanking pulse is ended with the trailing edge of vertical oscillator discharge pulse. The device has no information about the vertical retrace time. Therefore, it does not cover, by the blanking pulse, the whole vertical retrace period. By means of BlankMode I²C-bus bit, when at 1 (default), the blanking level (one of two according to PLL1 status) is made available on the HLckVBk permanently. The permanent blanking, irrespective of the BlankMode I²C-bus bit, is also provided if the supply voltage is low (under V_{CCEn} or V_{CCDis} thresholds), if the X-ray protection is active or if the V-drive signal is disabled by VOutEn I²C-bus bit.

Figure 18. Levels on HLckVBk composite output



V-early blanking	No	Yes	No	Yes
HPLL1 locked	Yes	Yes	No	No

Figure 19. Ground layout recommendations



10 INTERNAL SCHEMATICS

Figure 20.

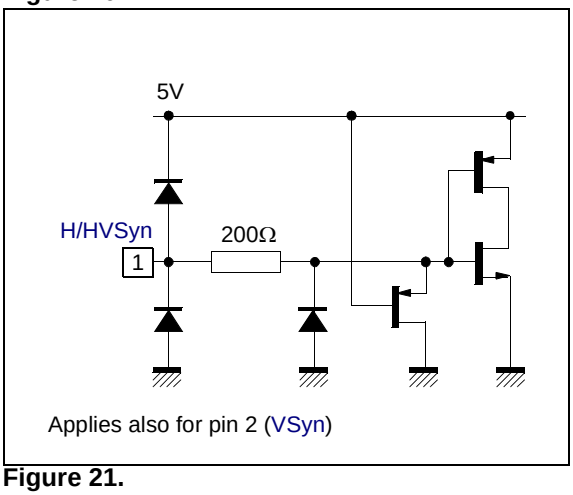


Figure 21.

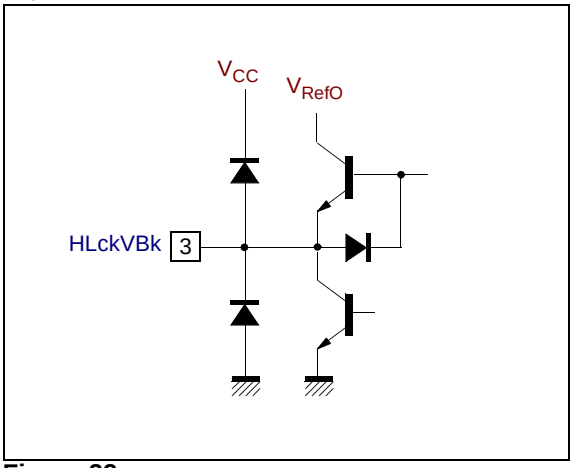


Figure 22.

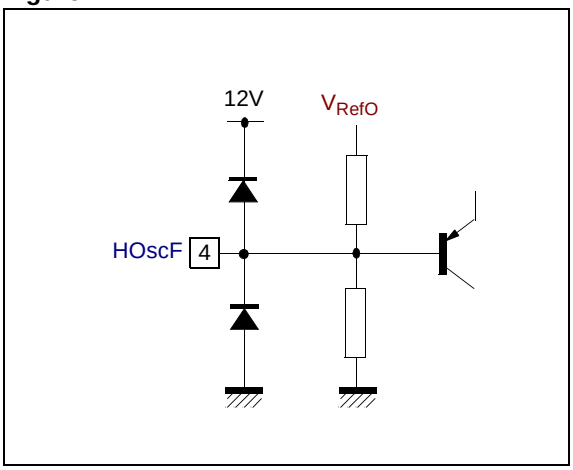


Figure 23.

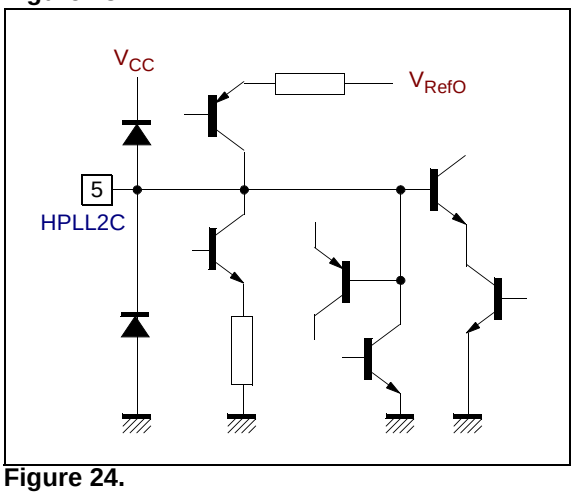


Figure 24.

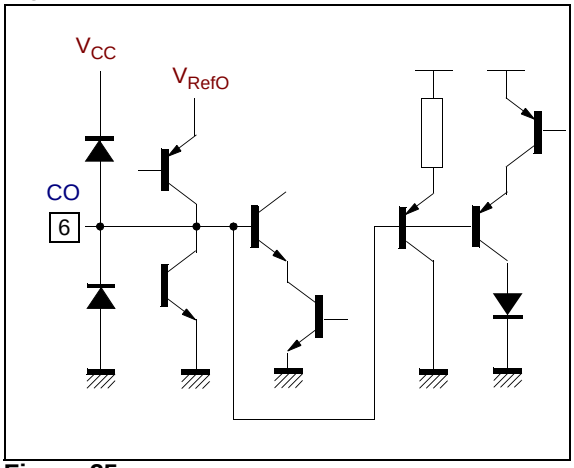


Figure 25.

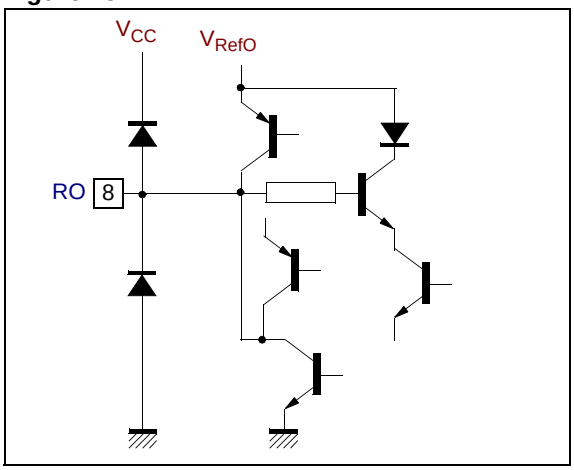


Figure 26.

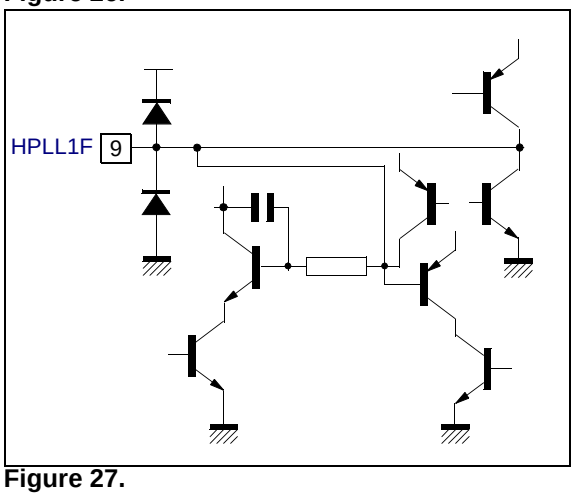


Figure 27.

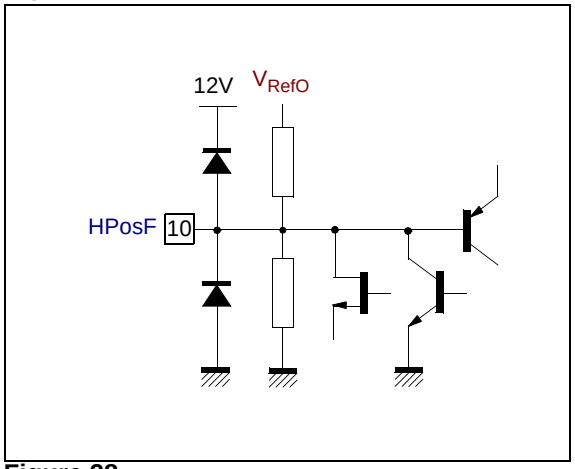


Figure 28.

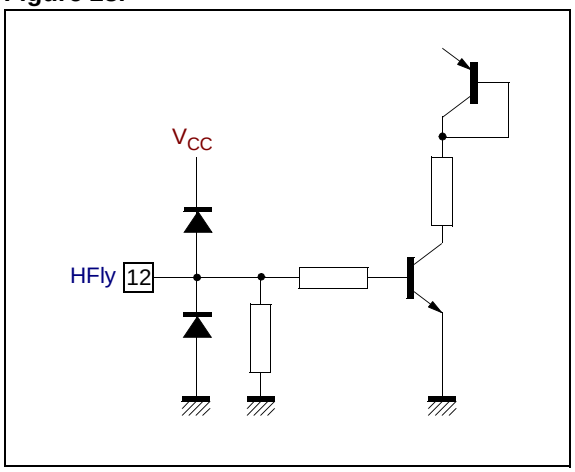


Figure 29.

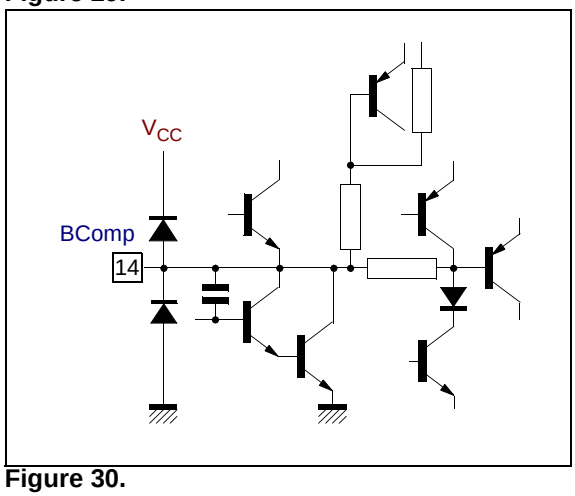


Figure 30.

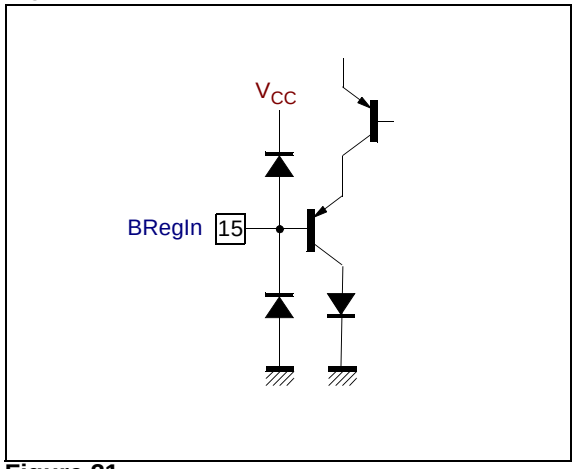


Figure 31.

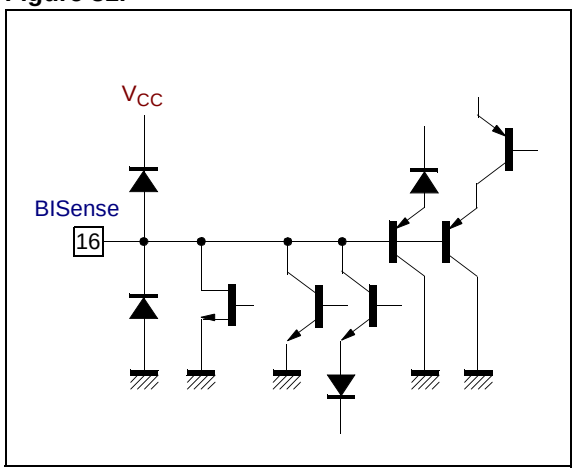


Figure 32.

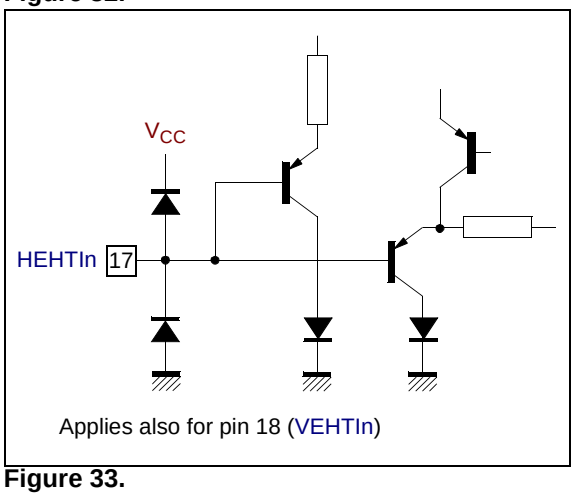


Figure 33.

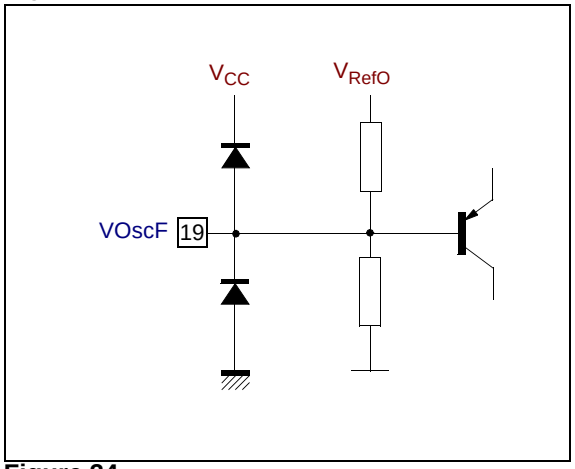


Figure 34.

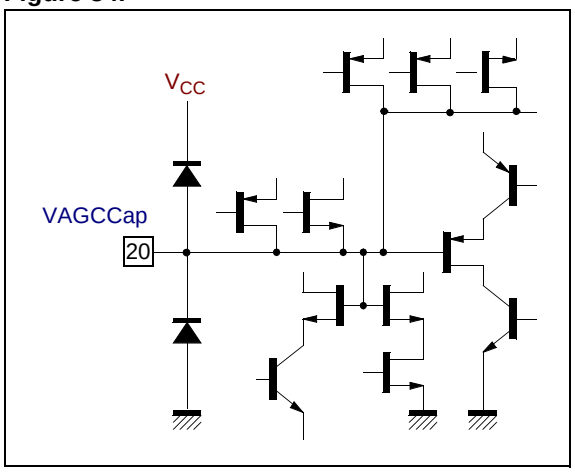
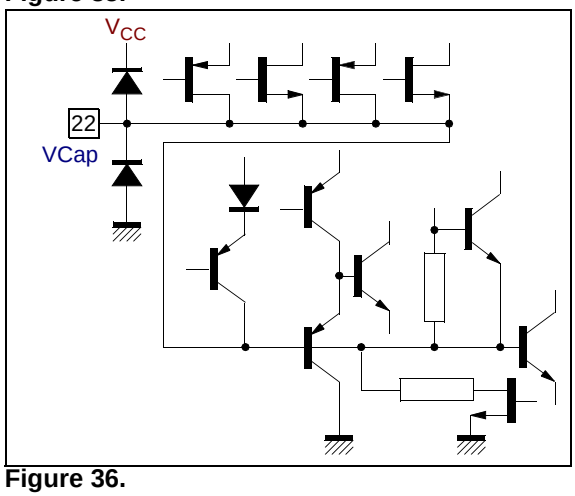


Figure 35.



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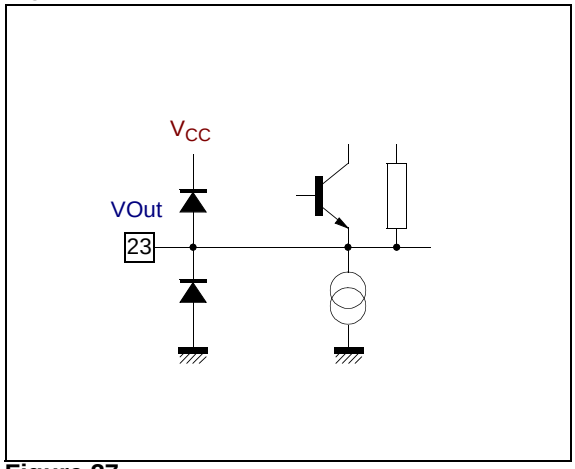


Figure 37.

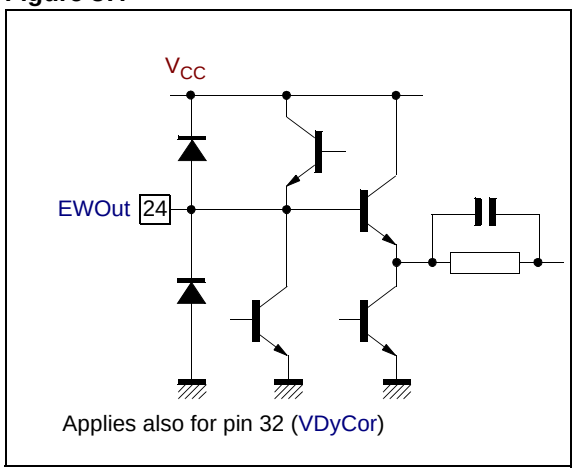


Figure 38.

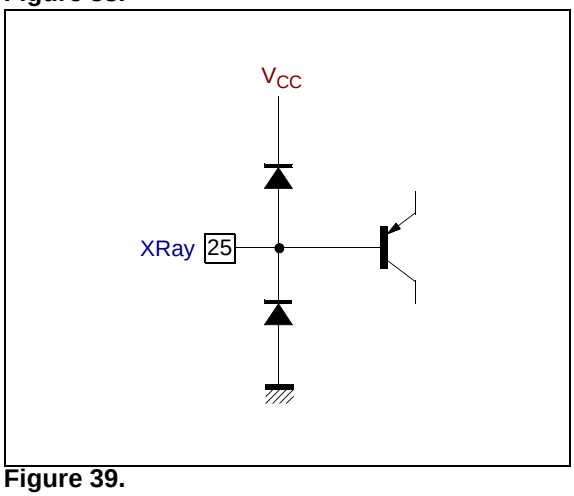


Figure 39.

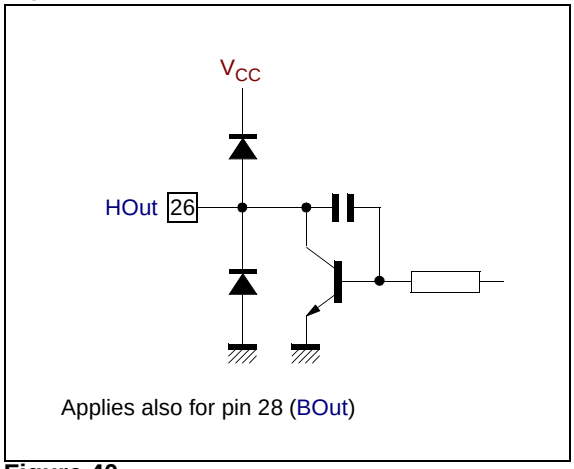
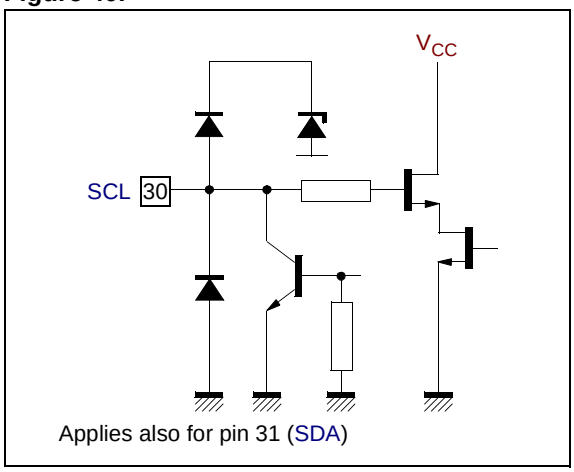
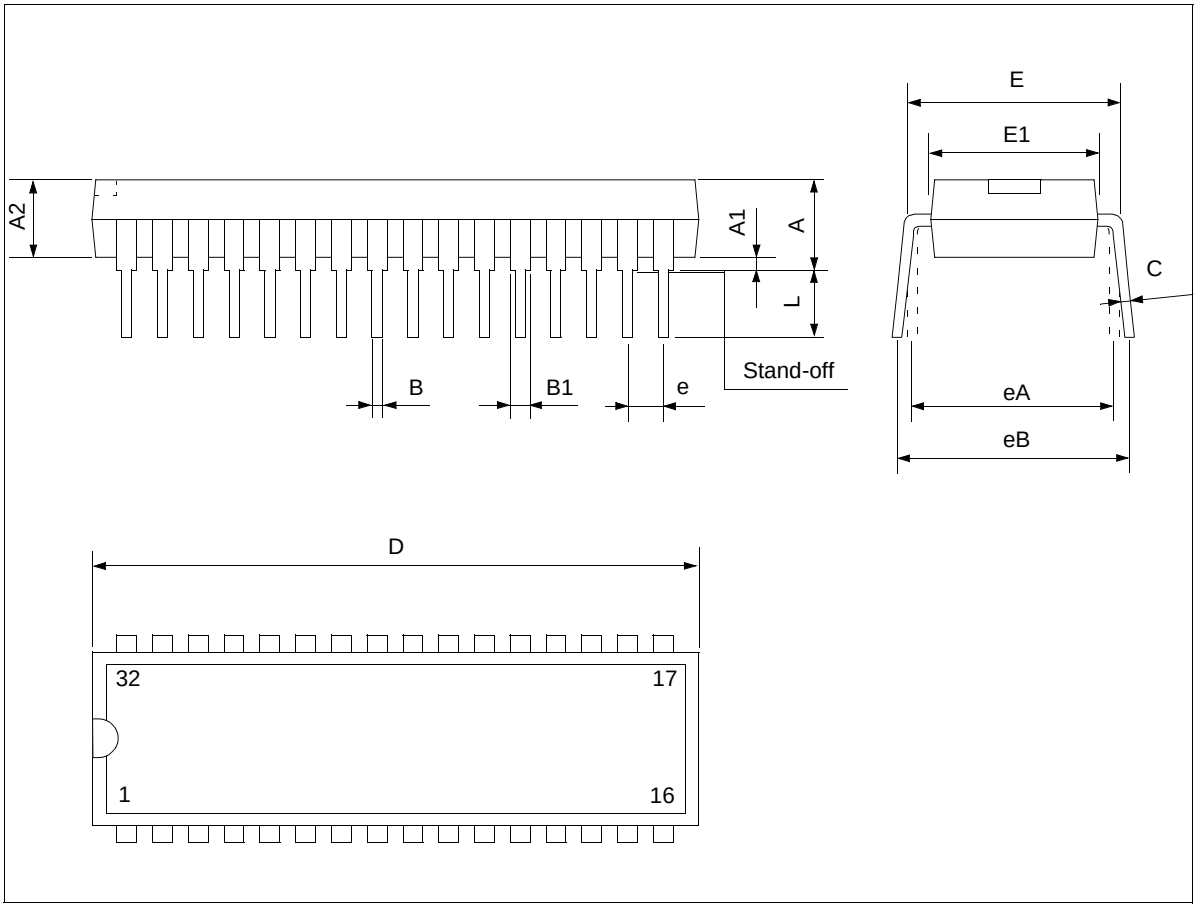


Figure 40.



11 PACKAGE MECHANICAL DATA

32 PINS - PLASTIC SHRINK



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	.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

12 GLOSSARY

AC	**A**lternate **C**urrent
ACK	**ACK**nowledge bit of I²C-bus transfer
AGC	**A**utomatic **G**ain **C**ontrol
COMP	**COMP**arator
CRT	**C**athode **R**ay **T**ube
DC	**D**irect **C**urrent
EHT	**E**xtra **H**igh **V**oltage
EW	**E**ast-**W**est
H/W	**H**ard**W**are
HOT	**H**orizontal **O**utput **T**ransistor
I^2C	**I**nter-**I**ntegrated **C**ircuit
IIC	**I**nter-**I**ntegrated **C**ircuit
MCU	**M**icro-**C**ontroller **U**nit
NAND	**N**egated **AND** (logic operation)
NPN	**N**egative-**P**ositive-**N**egative
OSC	**OSC**illator
PLL	**P**hase-**L**ocked **L**oop
PNP	**P**ositive-**N**egative-**P**ositive
REF	**REF**erence
RS, R-S	**R**eset-**S**et
S/W	**S**oft**W**are
TTL	**T**ransistor **T**ransistor **L**ogic
VCO	**V**oltage-**C**ontrolled **O**scillator