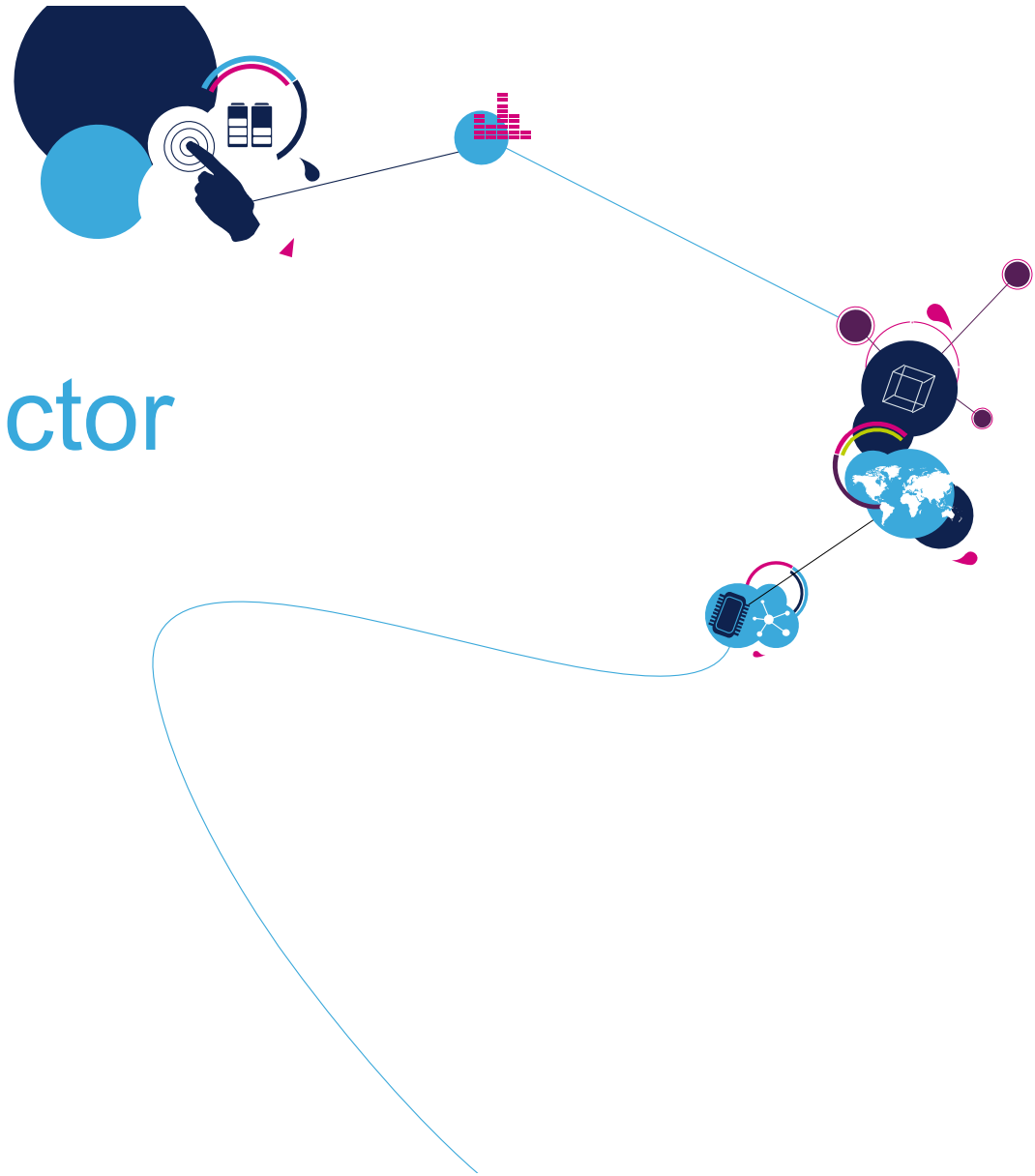


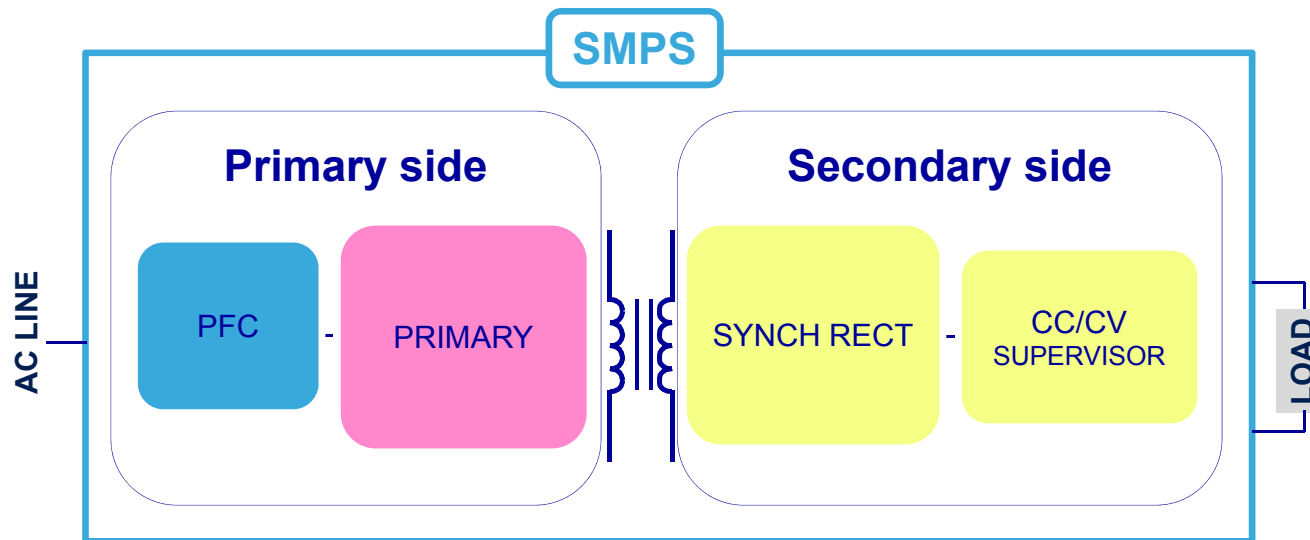
Power Factor Corrector Controllers

September 2015



PFC Controllers

- Functionality and Application
- ST PFC topologies and offer



PFC in Applications



COMPUTER PERIPHERAL

- Workstation
- Desktop PC
- Server
- Printer



INDUSTRIAL

- SMPS
- Home Appliance – White Goods
- AC-DC Adapters



CONSUMER

- Games
- Flat panel TV
- Set Top Box



LED Lighting

- LED luminaires
- Lamp ballast



ST PFC - Competitive Advantages

4



Performance & Solution Cost

- Allow THD reduction making SMPS more efficient and compliant with EN61000-3-2 and energy saving regulations
- Solutions from 25W up to 3kW



Robustness and reliability

- Advanced protection features integrated
- Output Overvoltage, Brownout detection, inductor saturation detection, Feedback loop disconnection



Easy design

- Perfect Synergy with ST primary controllers for all topologies : Flyback, Quasi-Resonant & Resonant
- Full support and tools available



WW reference

- L6562A recognized as PFC world wide reference

A Power Factor Control is the SMPS stage connected to AC input Mains that addresses the need to limit THD

PFC pre-regulator between the bridge and the bulk draws from the mains a quasi-sinusoidal current in-phase with the line voltage

Harmonic current emission is regulated by standards EN 61000-3-2. Lighting requirements $> 25\text{W}$, SMPS & chargers $> 75\text{W}$

Maximize the energy delivery to load means to reduce the Total Harmonic Distortion (THD) and therefore maximize the Power Factor



PFC – Topologies & ICs Portfolio



TM Transition Mode

- | | |
|-------------------|-----------|
| • L6562A, L6562AT | DIP8, SO8 |
| • L6563H | SO16 |
| • L6563S | SO14 |
| • L6564D | SSOP10 |
| • L6564H | SO14 |
| • L6564T | SSOP10 |

CCM Continuous Conduction Mode

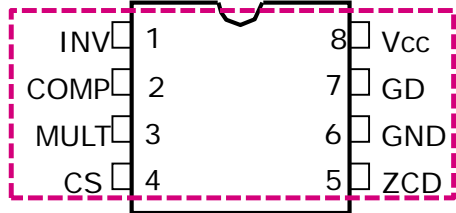
- | | |
|------------|-------------|
| • L4981A/B | DIP20, SO20 |
| • L4984D | SSOP10 |



PFC Transition-Mode Family positioning

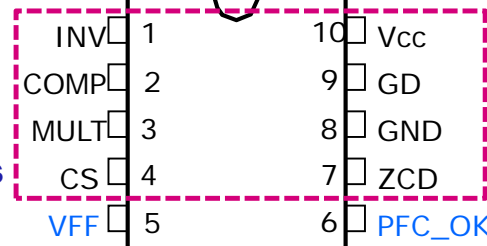


L6562A / AT

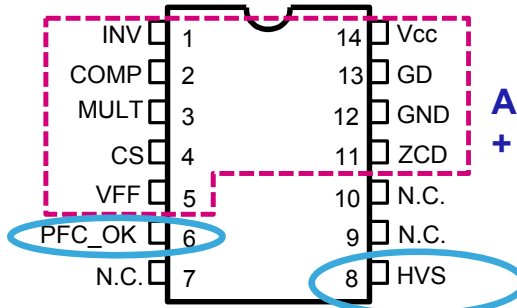


Low Cost
Advanced Features

L6564D / T



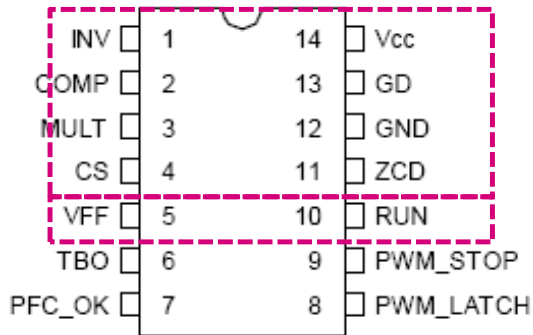
L6564H



Advanced features
+ High Voltage Start up

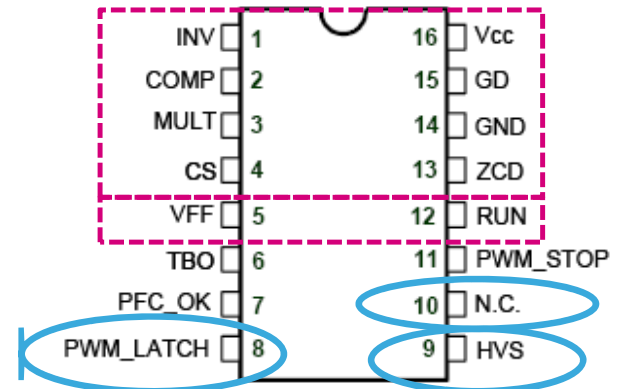
Interface to PWM ctrl

L6563S



Interface to PWM ctrl
+ High Voltage Start up

L6563H

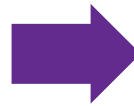


L6562 family – TM PFC

L6562A

8 pin

- Very accurate adjustable output overvoltage protection
- Ultra-low (30 μ A) start-up current
- Low (2.5mA) quiescent current
- Proprietary multiplier design for minimum THD
- Disable function
- Internal Voltage reference with 1% precision @ Tj = 25 °C
- Packages: DIP8, SO8



L6562AT

8 pin

- Same features and functions as L6562A
- Guaranteed for extreme temperature range (outdoor), down to -40°C
- Packages: DIP8, SO8

APPLICATIONS

- IEC61000-3-2 compliant SMPS (Flat TV, monitors, desktop PC, games)
- AC-DC adapter/charger up to 250W
- Electronic ballast
- Entry level server & web server



L6562A/T – Design Resources

• APPLICATION NOTES

- AN2755: 400 W FOT-controlled PFC pre-regulator with the L6562A
- AN2761: Solution for designing a transition mode PFC preregulator with the L6562A
- AN2782: Solution for designing a 400 W fixed-off-time controlled PFC preregulator with the L6562A
- AN2835: 70 W HID lamp ballast based on the L6569, L6385E and L6562A
- AN2838: 35 W wide-range high power factor flyback converter evaluation board using the L6562A
- AN2928: Modified buck converter for LED applications
- AN2983: Constant current inverse buck LED driver using L6562A
- AN3111: 18 W single-stage offline LED driver
- AN3105: 48 V - 130 W high efficiency converter with PFC for LED street lighting applications - European version
- AN3106: 48 V - 130 W high-efficiency converter with PFC for LED street lighting applications

• EVALUATION BOARDS & TOOLS

- EVL6562A-400W L6562A 400W FOT-controlled PFC pre-regulator evaluation board
- EVL6562A-35WFLB 35W WIDE RANGE HIGH POWER FACTOR FLYBACK CONVERTER USING THE L6562A
- STEVAL-ILL013V1 80 W offline PFC and LED driver demonstration board with dimming based on the L6562A
- EVL6562A-LED Constant current inverse buck LED driver using L6562A
- STEVAL-ILL027V2 18 W single-stage offline LED driver based on the L6562A (European version)
- STEVAL-ISA102V1 80 W high performance transition mode PFC demonstration board
- STEVAL-ILL042V2 60 W, high power-factor flyback LED driver based on the L6562AT and TSM101

L6563 family – TM PFC



L6563S

14 pin

- Easy and noise immune OCP and OVP circuitry
- Fast and bidirectional voltage feedforward
- Inductor Saturation Protection No Latched
- Voltage Reference precision 1% @ $T_j = 25\text{ }^\circ\text{C}$
- Tracking boost function
- Protection against feedback loop failure (Latched shutdown)
- Remote ON/OFF control
- Low ($\leq 90\mu\text{A}$) start-up current
- Quiescent current 5mA max.
- Adjustable Brownout
- PWM interface
- Package: SO14



L6563H

16 pin

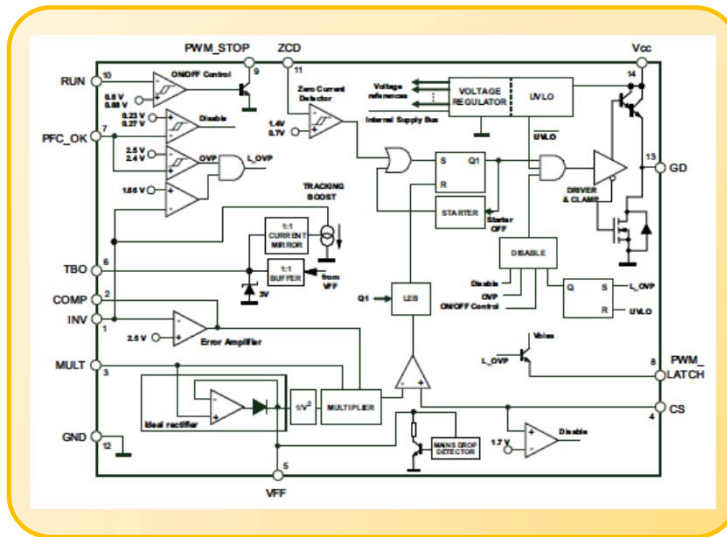
- Same features and functions as L6563S
- **High Voltage Start-up with on-board 700 V start-up source**
- Package: SO16

APPLICATIONS

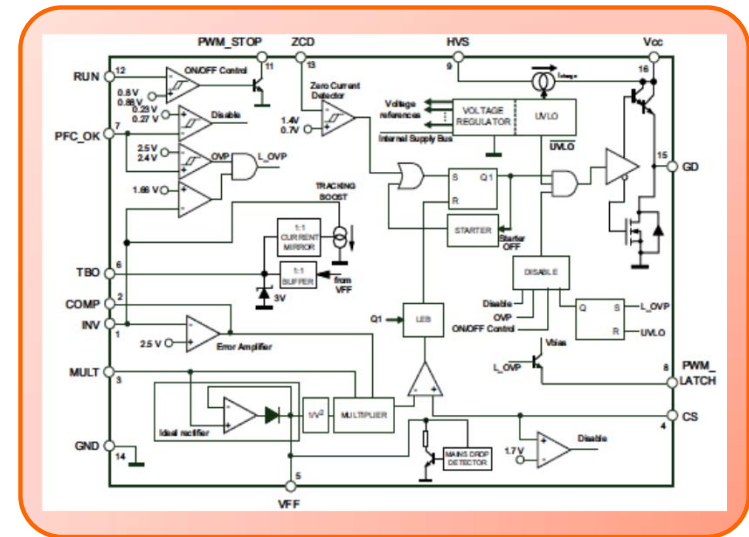
- HI-END AC-DC adapter/charger
- Desktop PC, server, WEB server
- IEC61000-3-2 OR JEIDA-MITI compliant SMPS, up to 250W
- SMPS for LED luminaires

L6563H & L6563S

L6563S



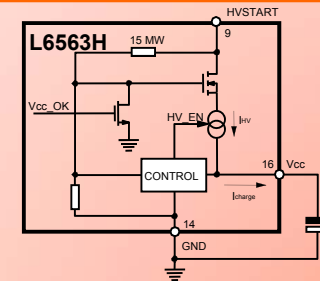
L6563H



MAIN FEATURES

- **OVP** → higher noise immunity
- **Fast and "Two ways" Voltage Feed forward** → Complete rejection of Mains surges and drops
- **PWM interface pin** → turn off PMW if PFC fault or PFC at light load
- **Inductor Saturation Protection No Latched** → higher reliability

HV STARTUP



- VBR= 700V
- ICHARGE = 0.85 mA Typ
- Min start Voltage: 80V Typ
- HV generator restart voltage: 6V/9.5V

L6563H & L6563S – Design Resources

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• APPLICATION NOTES

- AN3014: 19 V, 90 W resonant converter with synchronous rectification using the L6563H, L6599A and SRK2000
- AN3118: 250 W transition-mode PFC pre-regulator with the new L6563H
- AN3063: 100 W transition-mode PFC pre-regulator with the L6563H
- AN3172: 19 V - 90 W adapter with PFC for Laptop computers using the L6563H and L6599A
- AN3233: 12 V - 150 W resonant converter with synchronous rectification using the L6563H, L6599A, and SRK2000
- AN2941: 19 V - 75 W SMPS compliant with latest ENERGY STAR® criteria using the L6563S and the L6566A
- AN2994: 400 W FOT-controlled PFC pre-regulator with the L6563S
- AN3027 : How to design a transition-mode PFC pre-regulator with the L6563S and L6563H
- AN3065: 100 W transition-mode PFC pre-regulator with the L6563S
- AN3119: 250 W transition-mode PFC pre-regulator with the new L6563S
- AN3142: Solution for designing a 400 W fixed-off-time controlled PFC preregulator with the L6563S and L6563H
- AN3180: A 200 W ripple-free input current PFC pre-regulator with the L6563S
- AN3203: EVL250W-ATX80PL: 250W ATX SMPS demonstration board
- AN4027: 12 V - 150 W resonant converter with synchronous rectification using the L6563H, L6699 and SRK2000A
- AN4677: 12 V - 150 W resonant converter with synchronous rectification based on L6563H, L6699 and SRK2001

• EVALUATION BOARDS

- EVL6563S-100W 100 W transition-mode PFC pre-regulator with the L6563S
- EVL6563S-200ZRC A 200 W ripple-free input current PFC pre-regulator with the L6563S
- EVL6563S-250W 250W TRANSITION-MODE PFC PRE-REGULATOR WITH L6563S
- STEVAL-ISA149V1 19 V - 75 W SMPS compliant with latest Energy Star criteria using the L6563 and the L6566A
- STEVAL-ISA145V1 250 W ATX SMPS demonstration board
- STEVAL-ISA170V1 12 V - 150 W resonant converter with synchronous rectification based on L6563H, L6699 and SRK2001



L6564 family – TM PFC

L6564D 10 pin

- **Evolution of L6562A & Compact version of L6563S**
- AC brownout detection
- Protection against feedback loop disconnection (latched shutdown)
- Inductor saturation protection
- Low ($\leq 100 \mu\text{A}$) start-up current
- Max. operating bias current 6 mA
- Fast “bidirectional” input voltage feed-forward
- Accurate adjustable output overvoltage protection
- Package: SSOP10

L6564T 10 pin

- Same features and functions as L6564D
- **Electrical Parameters Guaranteed from -40°C to +125°C**
- **Recommended for OUTDOOR LED Luminaries.**
- Package: SSOP10

L6564H 14 pin

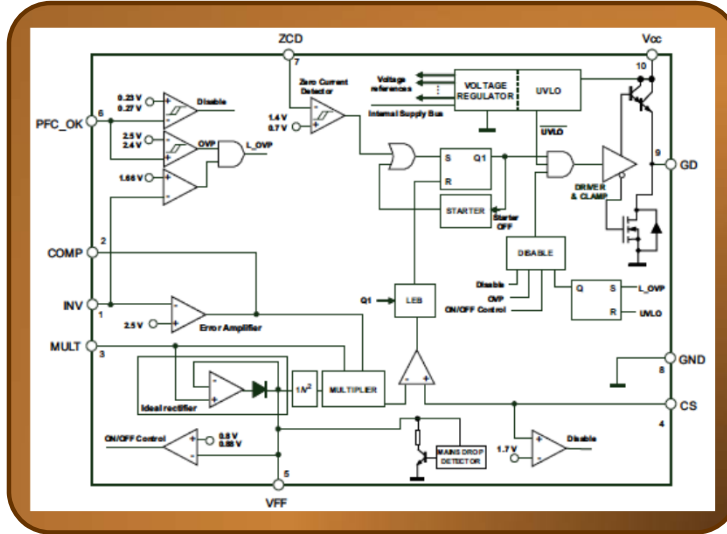
- Same features and functions as L6564D
- **Onboard 700 V startup source for high voltage startup**
- Package: SO14

APPLICATIONS

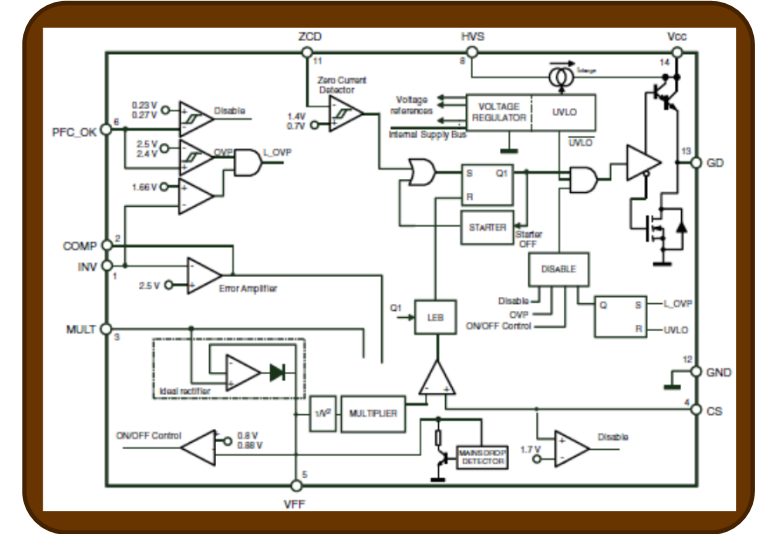
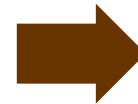
- HI-END AC-DC adapter/charger
- Desktop PC, server, WEB server, Flat TV
- IEC61000-3-2 OR JEIDA-MITI compliant SMPS, up to 250W
- SMPS for LED luminaires

L6564D/T & L6564H

L6564D/T



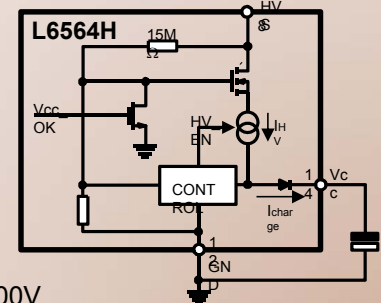
L6563H



MAIN FEATURES w.r.t. L6562A

- Suitable for more complex applications
- Full set of protections embedded
 - Brown-out, Inductor Saturation Detection, Feedback Disconnection
- Improved Noise immunity
- Voltage feed forward

HV STARTUP



- VBR= 700V
- ICHARGE = 0.85 mA Typ
- Min start Voltage: 80V Typ
- HV generator restart voltage: 6V/9.5V

L6564D/T & L6564H – Design Resources

• APPLICATION NOTES

- AN3009: How to design a transition mode PFC pre-regulator using the L6564D
- AN3112: Solution for designing a fixed off-time controlled PFC pre-regulator with the L6564D
- AN3329: 170 W power supply with PFC and standby supply for flat TV using the L6564D, L6599A, and Viper27LN
- AN3339: 185 W power supply with PFC and standby supply for LED TV using the L6564D, L6599A, and VIPER27LN
- AN3410: A 93% efficient LED driver solution for the US market
- AN4214: High power factor flyback converter using L6564D
- AN4339: BLDC motor based ceiling fan solution proposal
- AN4077: 100 W transition-mode PFC pre-regulator with the new L6564H
- AN4314: 25 W wide-range high power factor buck-boost converter demonstration board using the L6564H

• EVALUATION BOARDS

- STEVAL-ISA142V1 50 W wide-range high power factor flyback converter using the L6564D
- EVL6564-100W L6564 transition mode PFC evaluation board
- STEVAL-ILL041V1 A 93% efficient LED driver solution for the US market
- EVL6564H-25W-BB 25 W wide-range high power factor buck-boost converter demonstration board using the L6564H

L6562A/T

- STSW-PFC001
Software tool for designing a power factor corrector using the L6562A controller operating in transition mode
- Power factor corrector L6562A in flyback topology
http://ims.st.com/pub/documents//ipc/off-line_power_supply/software/L6562ATL431Flyrelease20.xls
- Power factor corrector L6562A in transition mode
http://ims.st.com/pub/documents//ipc/off-line_power_supply/software/L6562A%20PFC_TM_release%201.3.xls
- Power factor corrector L6562A with fixed off-time control
http://ims.st.com/pub/documents//ipc/off-line_power_supply/software/L6562A%20FOT%20release%201.4.xls

L6563H & L6563S

- DESIGNING A TM PFC USING THE L6563S (AVAILABLE UPON REQUEST)
http://ims.st.com/pub/documents/ipc/off-line_power_supply/software/L6563S_H_TMPFC_release30.xls
- DESIGNING A FOT PFC USING THE L6563S (AVAILABLE UPON REQUEST)
http://ims.st.com/pub/documents//ipc/off-line_power_supply/software/L6563S_H_FOTrelease30.xls

L6564D/T & L6564H

- DESIGNING A TM PFC USING THE L6564 (AVAILABLE UPON REQUEST)
http://ims.st.com/pub/documents/ipc/off-line_power_supply/software/L6564TMPFC_release20.xls
- DESIGNING A FOT PFC USING THE L6564 (AVAILABLE UPON REQUEST)
http://ims.st.com/pub/documents/ipc/off-line_power_supply/software/L6564FOTrelease20.xls
- DESIGNING A High Power Factor Flyback USING THE L6564 (AVAILABLE UPON REQUEST)
http://ims.st.com/pub/documents/ipc/off-line_power_supply/software/L6564_TL431Fly_release_10.xls



L4981A, L4981B

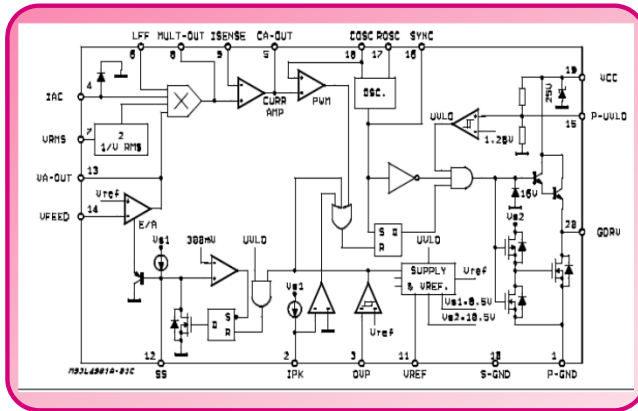
Fixed Frequency CCM PFC

17

Features

- Average Current Mode PWM controller with Power Factor up to 0.99
- L4981A: Fixed Frequency operation - L4981B: Frequency Modulation
- Universal Input Mains: 85V to 265V without any line switch
- Input voltage Feed-forward
- Load feed forward improving load transient
- UVLO with hysteresis and programmable turn-on threshold
- OVP/OVC protection
- Low start-up current <0.5mA
- Precise 2% on-chip reference externally available
- Synchronization available (L4981A only)
- Packages: DIP20, S020

L4981A/B



Application Notes

- **AN1606** A "bridgeless PFC configuration" based on L4981 PFC controller
- **AN2649** A power factor corrector with MDmeshII and SiC diode
- **AN510** Circuits for power factor correction with regards to mains filtering
- **AN628** Designing a high power factor switching preregulator with the L4981 continuous mode
- **AN827** A 500W High Power Factor with the L4981A continuous Mode IC
- **AN828** 1500W - 440V power factor corrector preregulator
- **AN829** Semiconductor kit for Power Factor Corrector
- **AN832** L4981A Synchronization
- **AN833** Frequency Modulation on L4981B

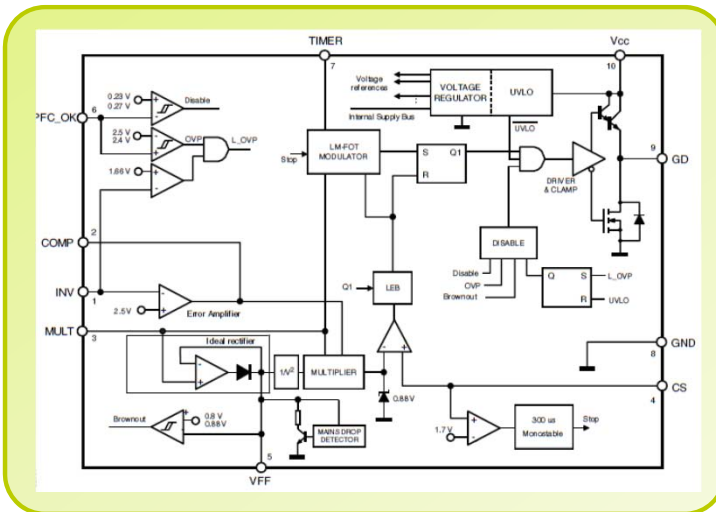
L4984D – CCM PFC

18

Features

- Line-modulated fixed-off-time (LM-FOT) control – proprietary solution - for nearly fixed frequency operation
- Low Start-up Current (<100µA)
- Fast Bidirectional Input Voltage Feedforward ($1/V^2$ correction)
- Precise Internal Reference (1% @25C)
- Protection against Feedback Loop Failure (Latched Shutdown)
- AC Brownout Detection
- Adjustable OVP on output voltage (No Latched)
- Inductor saturation protection (No Latched)
- Open loop protection
- Input Mains under-voltage detection
- Digital Leading-edge blanking on Current Sense
- Soft Start
- Remote ON/OFF control input pin
- Package: SSOP10


L4984D



Application Notes & Evaluation Boards

- **AN4149:** Designing a CCM PFC pre-regulator based on the L4984D
- **AN4163:** EVL4984-350W: 350 W CCM PFC pre-regulator with the L4984D
- **EVL400W-ADP/ATX** 12V - 400W SMPS for Adapter, Desktop and AIO using L4984D, L6699 and SRK2000A
- **EVL4984-350W** 350 W CCM PFC pre-regulator demonstration board based on the L4984D

Competitive Advantages

- 
- Right solution for **middle-high power SMPS**
 - Best **trade-off between full set features, performance and price, form factor**
 - Address a **wide range of applications**: from simple, such as high-end game consoles, desktop, and workstation to the more complex high-end servers, EV battery chargers, solar inverters or SMPS for data centers

Proprietary LM-FOT modulator for nearly fixed frequency operation

- Simple design and reduced BOM

Fast bidirectional input voltage feed forward

- Mains drops and surges rejection

Soft start

- Perfect inrush energy management

Proprietary THD optimizer circuit

- Enhanced performance

Full set protections embedded

- Prevent from inductor and MOSFET damage, bulk capacitors burning and down stream converter damaging

Mid Power LED lighting: directions & solutions



Single Stage

Isolated Fly Back
→ L6562A – L6564D/H

**Not Isolated Flyback
(Buck-Boost)**
→ L6564H

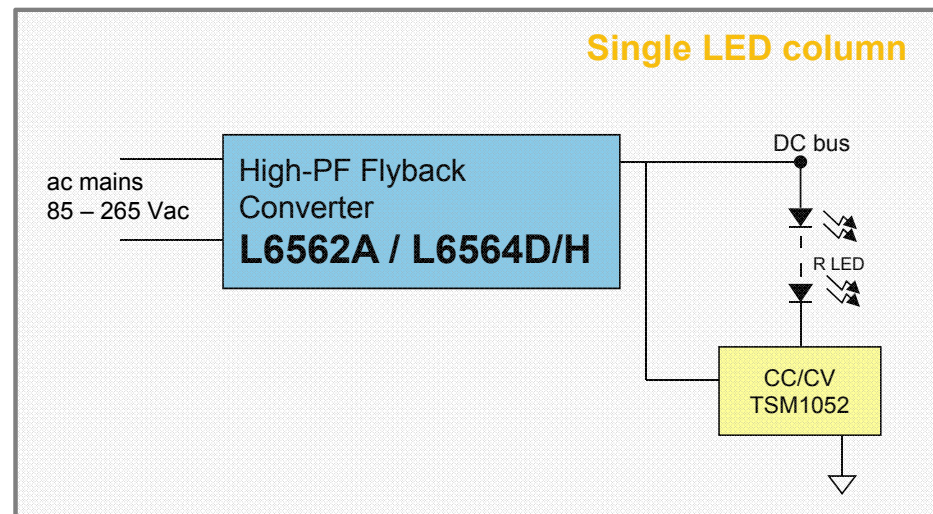
Dual Stage

Boost + Inversed Buck
→ L6562A - L6562A

- **Low Cost** solution for medium power Lighting applications in the range 25W to 80W

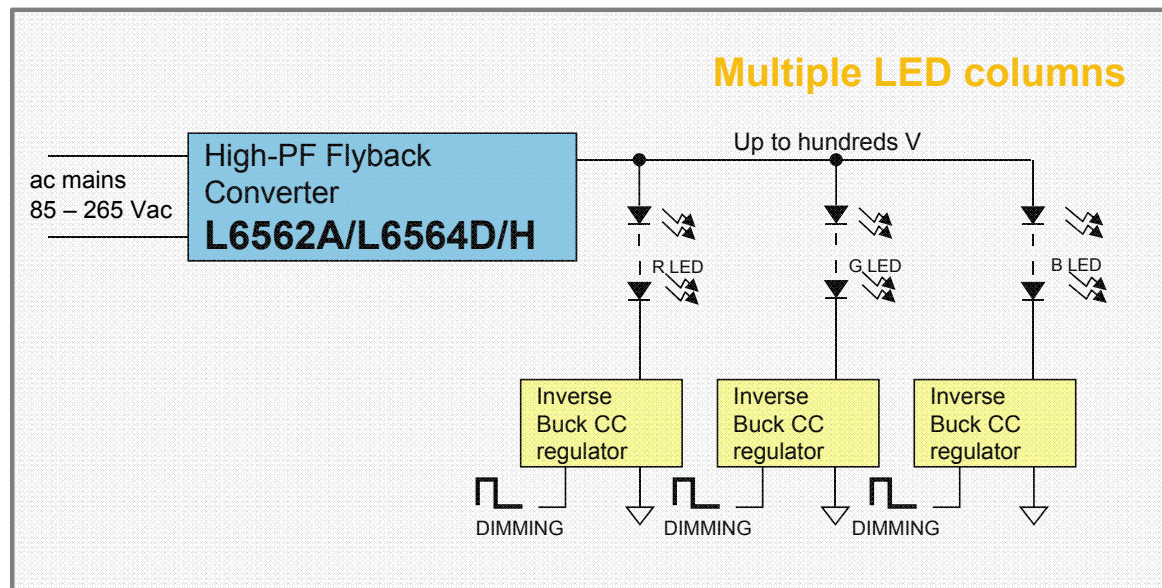
- **Low THD** and **high PF**

Isolated flyback – Single LED column



- Cheap and flexible
- Work in wide range input voltage solutions
- No electrolytic input capacitor, no electrolytic output capacitor according to acceptable ripple current
- PF > 0.9 and Efficiency up to 90% thanks to Quasi-resonant topology
- Most used low cost solution up to 80/90W for commercial and industrial fixtures
- Open/Short protections embedded
- Compliant with the European regulation EN61000-3-2 Class-C and Japanese regulation JEIDA-MITI Class-C
- **AN2838 EVL6562A-35WFLB, STEVAL-ISA142V1**

Isolated flyback – Multiple LED columns (1/2)

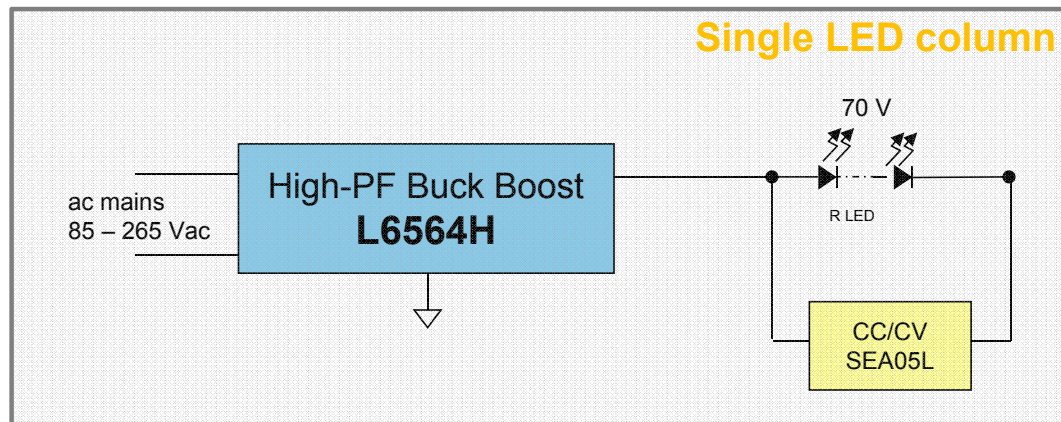


- For Multiple LED Columns the L6562A based Inversed buck is the simplest and cheapest solution (see next slide)
- **AN2983-AN2928 (EVAL6562A-LED)**

Non-Isolated flyback – Buck Boost

25

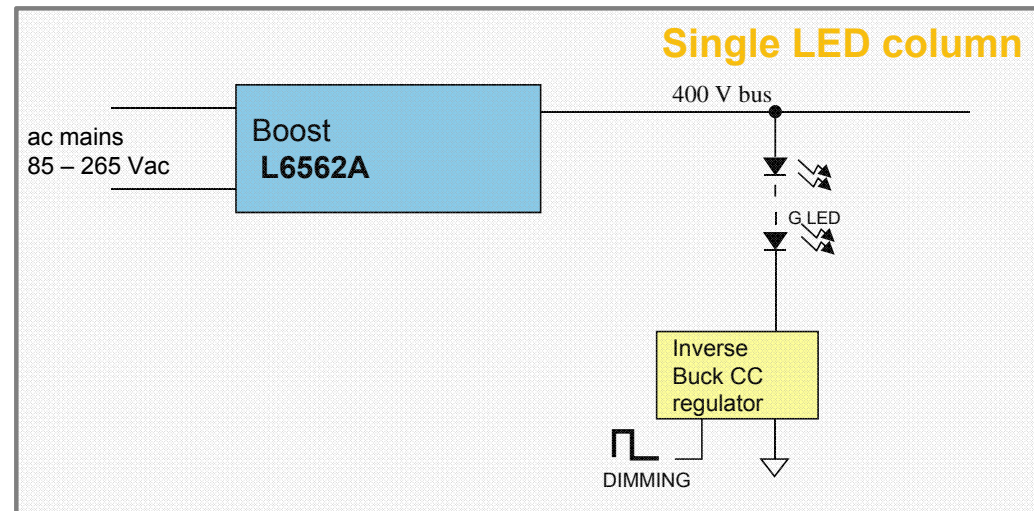
- Wide Input Range, cost effective, high PF not isolated solution for LED Tube and Ceiling



- Line voltage range: 85 to 265 VAC
- No transformer, No Photo-coupler
- LED string voltage drop: 70 V \pm 10% (23 LED p.n. X42182)
- LED nominal current: 350mA
- Rated output power: 25 W
- Conducted EMI: In acc. with EN55022 Class-C
- Protections to overvoltage, open loop and short circuit
- **AN4314, EVL6564H-25W-BB**

Dual stage - Boost + Inversed Buck

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- Optimum Power Factor and very low THD over wide input voltage range

- STEVAL-ILL013V1**: demo board for general purpose LED applications based on L6562A used in Boost topology and a second stage using L6562A Inversed buck
- UM0670** documentation

Thank you!

