TND316/D
Rev. 1, Sep-06

ON Semiconductor®

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From ON Semiconductor

220 W LCD TV Power Supply Documentation Package

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1 Overview

This reference document describes a built-and-tested, GreenPoint™ solution for an LCD TV power supply.

The reference design circuit consists of one single-sided 130 mm x 200 mm printed circuit board designed to fit into an LCD TV. Height is 25 mm.

An overview of the entire circuit is provided by Figure 1. As shown in that figure, ON Semiconductor devices are available for every block of the LCD TV power supply; and by judicious choice of design tradeoffs, optimum performance is achieved at minimum cost.

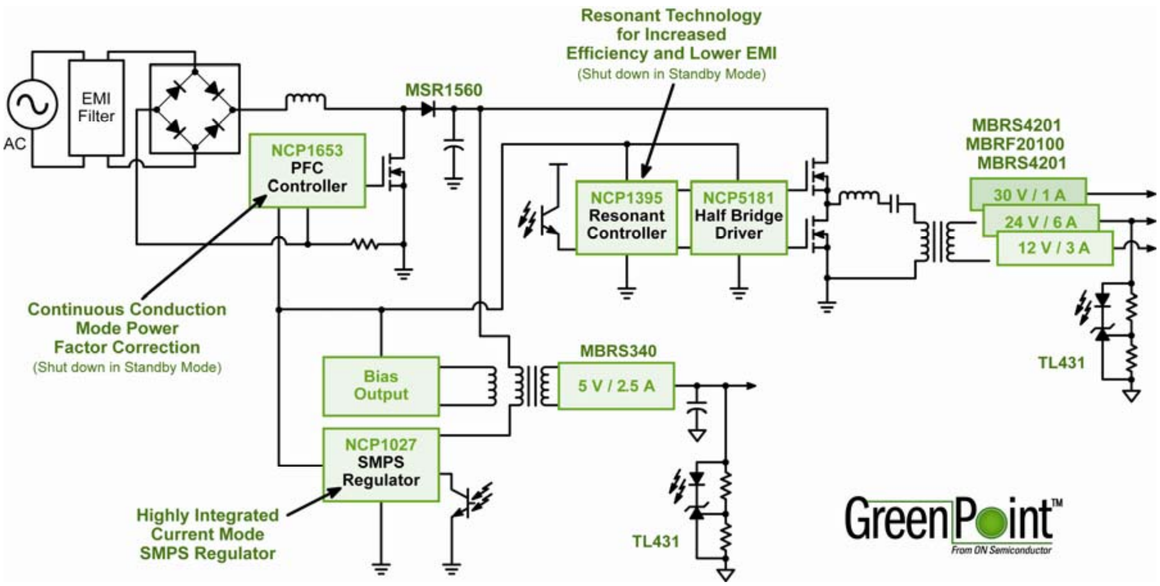


Figure 1

2 Introduction

From Tubes to Flat TVs

Since 1936 when the BBC begins the world's first public-television broadcast in London, the TV world made huge progress. A few examples:

- 1953: color broadcasting
- 1956: first VCR
- 1962: first television satellite (Telstar)
- 1981: NHK (Japan) demonstrates an HDTV system

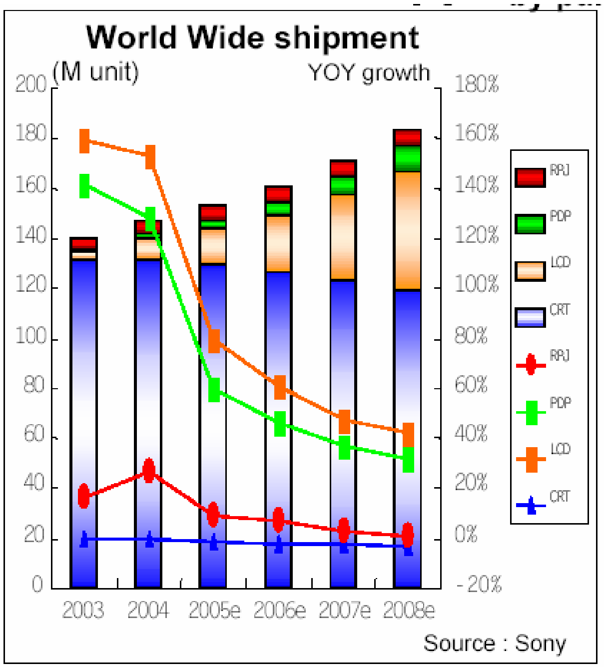
But "the idea of sitting in front of a box in your living room is becoming obsolete. For the TV industry, technology is creating vast opportunities". – Newsweek, June 2005.

Obviously Flat Panel Display (FPD) is one of the technologies that will drive these opportunities:

- High Definition TV (HDTV): Most of the flat TVs on the market are ready to cope with a higher resolution (more lines are needed and a classical CRT TV can not handle it). More and more events will use this new standard. As an example the 2006 Football World Cup will be broadcast in HDTV.
- Digital TV: The analog TV signal will be shut down soon in Europe, as it is replaced by Digital Terrestrial signal. Satellite and Cable Digital decoders are already very common. To get the best out of these digital signals, a high definition TV is definitively a plus. Digital TV will also allow CD-quality audio and six channels of surround sound.
- Bigger screen, smaller form factor: Now that we all have seen these fancy screens, who is willing to go back to the old big bulky box?

FPD includes both LCD (Crystal Liquid Display) and Plasma technologies.

Despite the fact that classical CRT TV will remain the main stream in TV worldwide shipment, FDP is expected to expand at a rapid growth. The CRT market is shrinking very rapidly in Europe, Japan and US.



RPJ: Rear ProJection
PDP: Plasma Display Panel
LCD: Liquid Crystal Display
CRT: Cathode Ray Tube

3 LCD TV Power Supply Requirements

In large FPD (> 27"), the power supply is generally internal as it requires from 100 W to 600 W. A few voltages are needed to supply the various blocks: backlighting, audio, video, demodulation, etc.

Because the input power is above 75 W, the application has to be compliant with the IEC1000-3-2 class D standard. Power Factor Correction is therefore needed. Since the main power supply has to be optimized for higher efficiency and slimmer form factor, an active PFC must be implemented to limit the variation of the input voltage in front of the main PSU.

Most of the LCD TV power supplies are designed to cope with universal mains: 90 Vac to 265 Vac, 47-63 Hz.

CCFL lamps (Cold Cathode Fluorescent) are mainly used for the backlighting. A 24 V rail is used to supply inverters that drive the lamps.

A 5 V auxiliary power supply is needed to supply the microcontroller that must remain alive in standby mode.

Some flat TVs may also already integrate a Digital Tuner that needs 30 V.

Having a low consumption in standby mode is also a key requirement. Recent studies and in situ measurement campaigns have indicated that in the average EU household, between 5% and 10% of its total yearly electricity consumption is due to the standby mode of consumer electronics equipment and other apparatus. TV sets are obviously one of the biggest contributors.

In 1997, the European Commission concluded a negotiated agreement with individual consumer electronics manufacturers and the EU trade association EACEM, to reduce the stand-by losses of TVs and VCRs. In the year 2003 a new agreement for TVs and DVDs was concluded.

Many initiatives have been taken around the word. Even if these requirements are not yet standards, most of the manufacturers have already applied these rules in their designs.

Hereinafter the list of the most important initiatives:

Region / Country	Program name	Requirements for Televisions	Demoboard compliance
China	CECP	3 W	Yes
Korea	Energy Saving	3 W	Yes
European Union	EU Eco-Label	1 W 9 W with a STB	Yes
European Union	EU Code of Conduct	3 W with a STB	Yes
Europe	GEEA	1 W	Yes
US	Energy Star	1 W to 15 W New revision on going	Yes
US	1 Watt Executive Order	1 W	Yes

4 Limitations of existing solutions

One of the key differentiating factors of a flat TV over a classical TV is the thickness of the cabinet - the thinner the better. But one must keep in mind:

- The amount of power to be delivered is relatively large: the number of watts per cm^3 is much larger compared to the one in a CRT TV.
- Because the TV will be used in the living room, audible noise can be a problem, and the use of fans is limited.
- Cost is key in the very competitive environment of the consumer electronics world.
- The panel, the power supply and the audio card are close to each other; therefore EMI and pollution could severely alter the picture and sound quality.

High efficiency and a low EMI signature at a reasonable cost are required, and classical topologies can hardly combine these needs:

- Flyback: transformer usage is far from being optimal
- Forward: the EMI signature is not reduced to its minimum

5 Overcoming limitations with NCP1653 / NCP1395 + NCP5181 / NCP1027

5.1 Architecture Overview

First, the use of active power factor correction in the front-end allows system optimization because the PFC output voltage is well regulated. The implementation of the active PFC front end is made simpler by using the NCP1653, an 8-pin Continuous Conduction Mode (CCM) PFC controller. By choosing the CCM approach for PFC, the peak and rms currents are kept low and better efficiency is achieved in the PFC stage. The output of the PFC stage is set at 385 V.

The SMPS stage uses a Half Bridge Resonant LLC topology. This topology offers a number of advantages as demonstrated in the schematics and the results. It improves efficiency, reduces EMI signature and provides better magnetic utilization. The NCP1395 controller and NCP5181 driver are used to implement the most effective control scheme of Half Bridge Resonant LLC converter.

For the standby output circuit, a higher integration level is made feasible by using the NCP1027, a PWM regulator that also incorporates an appropriate switch to provide all functionality in one package. The use of the true current mode control technique in NCP1027 allows better regulation of the standby power supply. During the standby mode both the PFC and the main PSU are shut off via the signal so called “SBE”. Thus, only the 5 V rail remains supplied and allows the compliance with the international recommendations.

In summary, the architecture selected for this reference design allows design optimization so that the desired performance is achieved without increasing the component costs and circuit complexity too much. The performance results section demonstrates the performance.

5.2 Main power supply: NCP1395 + NCP5181

5.2.1 Half Bridge Resonant LLC topology

The Half Bridge Resonant LLC topology, that is a member of the Series Resonant Converters (SRC), begins to be widely used in consumer applications such as LCD TVs or plasma display panels. In these particular applications, the output power level ranges from 100 W up to 600 W.

The Half Bridge Resonant LLC converter is an attractive alternative to the traditional Half Bridge (HB) topology for several reasons. Advantages include:

- **ZVS (Zero Voltage Switching) capability over the entire load range**: Switching takes place under conditions of zero drain voltage. Turn-on losses are thus nearly zero and EMI signature is improved compared to the HB, which operates under hard-switching conditions.
- **Low turnoff current:** Switches are turned off under low current conditions, and so the turn-off losses are also lowered compared to the HB topology.
- **Zero current turnoff of the secondary diodes:** When the converter operates under full load, the output rectifiers are turned off under zero-current conditions, reducing the EMI signature.
- **No increased component count:** The component count is virtually the same as the classical half bridge topology.

Figure 2 is the structure of this resonant converter. A 50 % duty-cycle half-bridge delivers high-voltage square waves swinging from 0 to the input voltage V_{IN} to a resonating circuit. By adjusting the frequency via a voltage-controlled oscillator (VCO), the feedback loop can adjust the output level depending on the power demand.

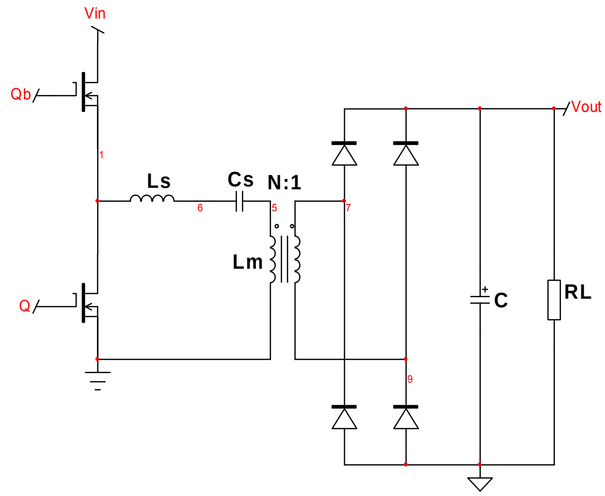


Figure 2

The resonating circuit is made of a capacitor, *Cs,* in series with two inductors, *Ls* and *Lm*. One of these inductors, *Lm*, represents the magnetizing inductor of the transformer and creates one resonating point together with *Ls* and *Cs*. The reflection of the load over this inductor will either make it disappear from the circuit (*Lm* is fully short-circuited by a reflected *RL* of low value at heavy load currents) or will make it stay in series with the series inductor *Ls* in light load conditions. As a result, depending on the loading conditions, the resonant frequency will move between a minimum and a maximum:

$$F_{max} = F_S = \frac{1}{2\pi\sqrt{L_S C_S}}$$

$$F_{min} = \frac{1}{2\pi\sqrt{(L_S + L_m)C_S}}$$

The frequency of operation depends on the power demand. For a low power demand, the operating frequency is rather high, away from the resonating point. To the contrary, at high power, the control loop reduces the switching frequency and approaches one of the resonant frequencies to deliver the necessary amount of current to the load.

This topology behaves like a frequency dependent divider.

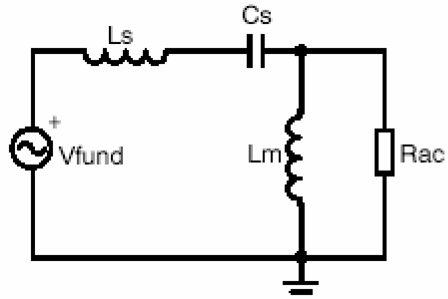


Figure 3: Substitutive schematic of the LLC resonant converter

$$R_{ac} = \frac{8 \cdot R_L}{\pi^2 \cdot n^2 \cdot \eta}$$

Where:
R_L is the real loading resistance
n is the transformer turns ratio
η is the expected efficiency

5.2.2 Protection

The NCP1395 differs from other resonant controllers thanks to its protection features. The device can react to various inputs like:

- **Fast events input:** Like an over-current condition, a need to shutdown (sleep mode) or a way to force a controlled burst mode (skip cycle at low output power).
- **Slow events input:** This input serves as a delayed shutdown, where an event like a transient overload does not immediately stop pulses but starts a timer. If the event duration lasts longer than what the timer imposes, then all pulses are disabled.

5.2.3 Half bridge driver: NCP5181

In a Half Bridge Resonant LLC the upper MOSFET is connected to the high voltage rail, therefore it can not be directly driven by the controller (NCP1395) that is referenced to the ground: a “level shifter” is needed.

The NCP5181 performs this function as it is a High Voltage Power MOSFET Driver that provides two outputs to drive two N-channel power MOSFETs. The NCP5181 uses the bootstrap technique to ensure a proper drive of the high-side power switch. The driver works with two independent inputs to accommodate any topology (including half-bridge, asymmetrical half-bridge).

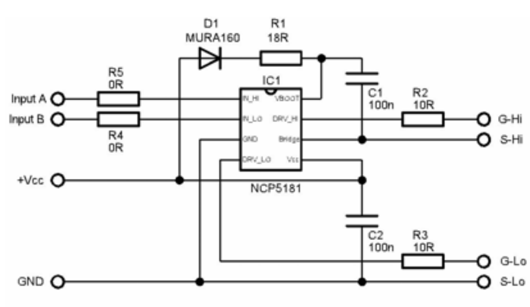


Figure 4: NCP5181

5.3 Standby Power Supply: NCP1027

A NCP1027 is used for the auxiliary flyback power supply. This power supply provides a stable Vcc to supply the NCP1653, the NCP1395 and the NCP5181 under all operating conditions, but it also supplies 5 V to the devices that must remain alive in standby mode.

NCP1027 characteristics:

- **Brown-out detection:** The controller will not allow operation in low mains conditions. You can adjust the level at which the circuit starts or stops operation.
- **Ramp compensation:** Designing in Continuous Conduction Mode helps to reduce conduction losses. However, at low input voltage (85 Vac), the duty-cycle might exceed 50% and the risk exists to enter a subharmonic mode. A simple resistor to ground injects the right compensation level.
- **Over power protection:** A resistive network to the bulk reduces the peak current capability and accordingly harnesses the maximum power at high line. As this is done independently from the auxiliary Vcc, the design gains in simplicity and execution speed.
- **Latch-off input:** Some PC manufacturers require a complete latch-off in the presence of an external event, e.g., over temperature. The controller offers this possibility via a dedicated input.
- **Frequency dithering:** The switching frequency (here 65 kHz) is modulated during operation. This naturally spreads the harmonic content and reduces the peak value when analyzing the signature.

5.4 Power Factor Correction: NCP1653

The NCP1653 is a controller for Continuous Conduction Mode (CCM) Power Factor Correction step-up pre-converters. It controls the power switch conduction time (PWM) in a fixed frequency mode and in dependence on the instantaneous coil current.

Housed in a DIP-8 or SO-8 package, the circuit minimizes the number of external components and drastically simplifies the PFC implementation. The NCP1653 is an ideal candidate in systems where cost-effectiveness, reliability and high power factor are the key parameters. It incorporates all the necessary features to build a compact and rugged PFC stage. More specifically, the following protections make the PFC stage extremely robust and reliable:

- **Maximum current limit:** The circuit immediately turns off the MOSFET if the coil current exceeds the maximum permissible level. The NCP1653 also prevents any turn on of the power switch as long as the coil current is not below this limit. This feature protects the PFC stage during the startup phase when large in-rush currents charge the output capacitor.
- **Undervoltage protection/shutdown:** The circuit stays in shutdown mode as long as the feedback current indicates that the output voltage is lower than 8% of its regulation level. In this case, the NCP1653 consumption is

very low (<50 µA). This feature protects the PFC stage from starting operation in case of too low AC line conditions or of a failure in the feedback network (e.g., bad connection).

- **Overvoltage protection:** Given the low bandwidth of the regulation block, PFC stages may exhibit dangerous output voltage overshoots because of abrupt load or input voltage variations (e.g., at startup). Overvoltage Protection (OVP) turns off the Power Switch as soon as Vout exceeds the OVP threshold (107% of the regulation level).

6 Specifications

Input Voltage: Universal input 85 Vac to 265 Vac, 47-63 Hz

Main Power Supply Output voltages:

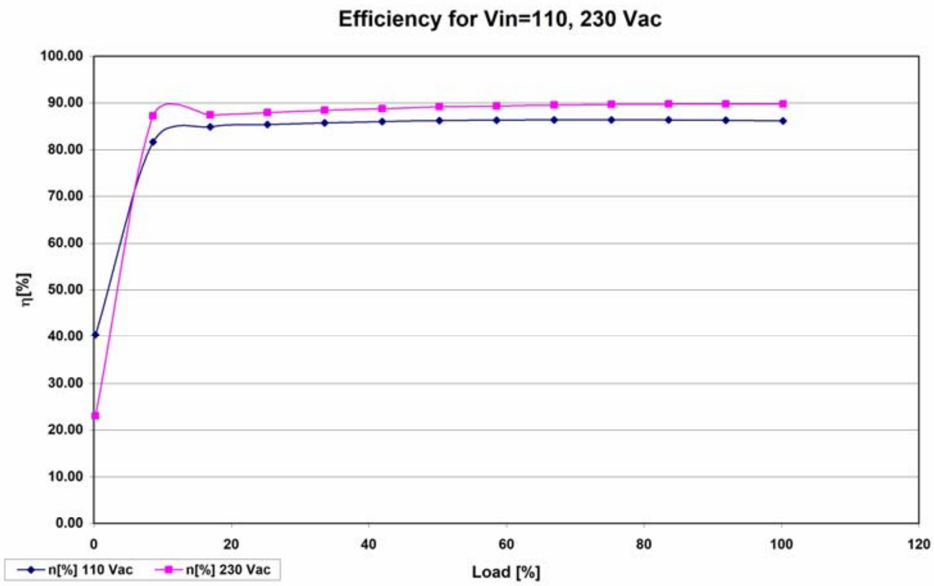
- 24 V / 6 A
- 12 V / 3 A
- 30 V / 1 A

Standby Power Supply:

- 5 V / 2.5 A
- Pin < 1 W when the consumption on the 5 V is < 100 mA

7 Reference Design Performance Summary

7.1 Efficiency



7.2 Standby Power

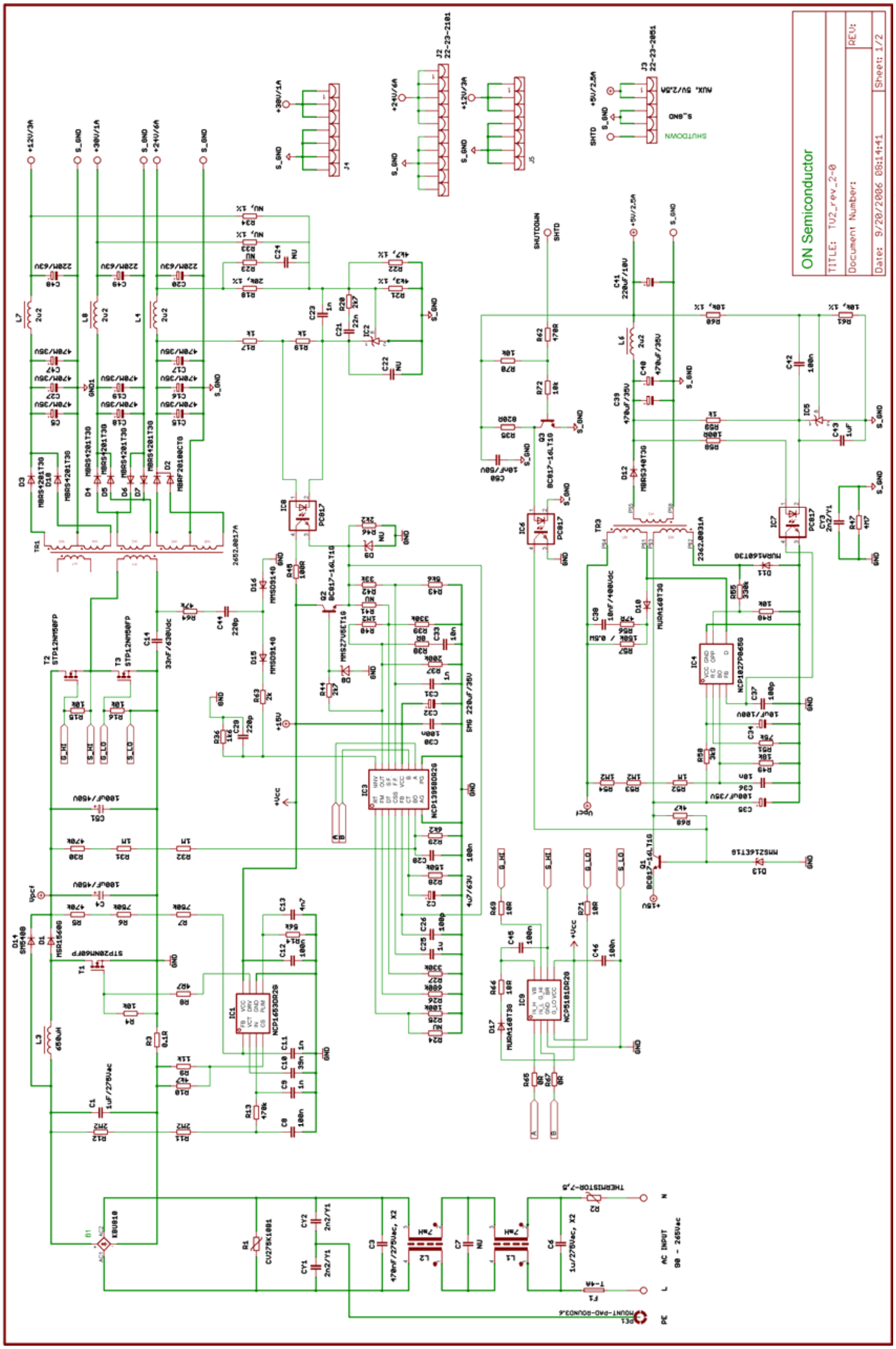
Input Voltage	Standby load	Power consumption
115 V	0.5 W	0.7614 W
230 V	0.5 W	0.9664 W

7.3 Standards and Regulations

Specification	Result
EN61000-3-2 – Limits for harmonic current emissions Class D *ČSN EN 61000-3-2*	Pass
EN61000-3-3 – Limits for voltage fluctuation and flicker for equipment with rated current < 16A *ČSN EN 61000-3-3*	Pass
EN61000-4-2 - ESD discharge *ČSN EN 61000-4-2+A1* Air - 15kV vertical plate - 8kV horizontal plate - 8kV	Pass Pass Pass
EN61000-4-3 – Radiated, RF, el. mag. field immunity test, distance 1m - 10V/m	Pass
EN61000-4-4 - Fast transient / burst immunity test L; N, L,N - 2kV *ČSN EN 61000-4-4+Z1*	Pass
EN61000-4-5 - Surge immunity test 1kV *ČSN EN 61000-4-5+Z1*	Pass
EN61000-4-6 - Elmg. field immunity to cond. Disturbances inducted by RF field *ČSN EN 61000-4-6+Z1*	Pass

8 Board Picture

9 Schematic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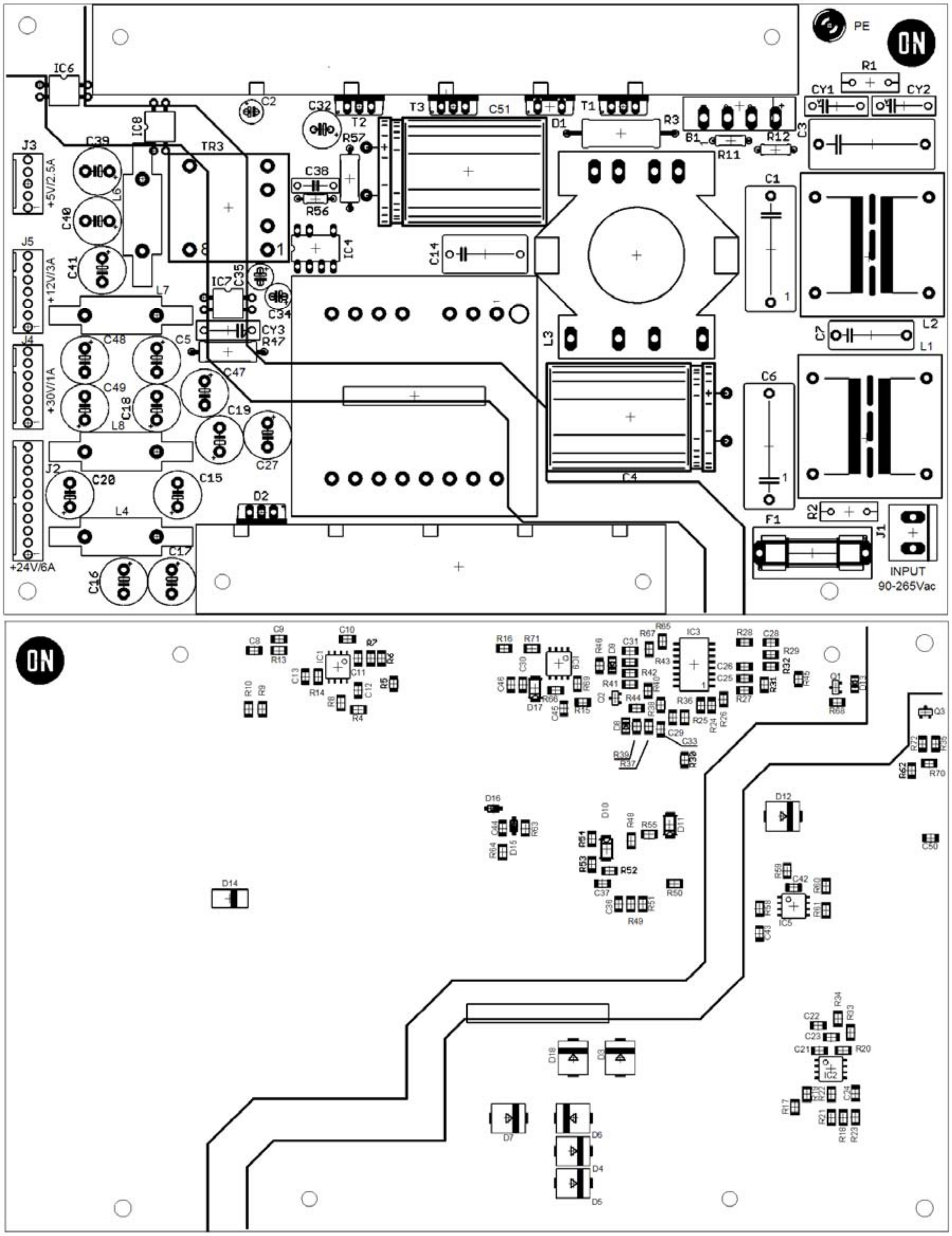
10 Board Layout



11 BOM

Ref Des	QTY	Description	Value	TOL	Manufacturer	MFG Part Number	SUB	Pb-Free
B1	1	BRIDGE RECTIFIERS 8Amp, 1000V	KBU810		various	–	YES	YES
C1, C6	1	CAPACITOR R46X2, MKP, 1uF/275Vac, RM22.5	1uF/275Vac		ARCOTRONICS	R46 KN 4100 –N2 M	YES	YES
C10	1	CERAMIC CAPACITOR, size 1206, X7R, 50V,	39n	20%	various	–	YES	YES
C13	1	CERAMIC CAPACITOR, size 1206, X7R, 50V,	4n7	20%	various		YES	YES
C14	1	CAPACITOR R73, KP, 0.033uF/630Vdc, RM15	0.033uF/630Vdc		ARCOTRONICS	R73PI 2330—0-K	YES	YES
C2	1	ELECTROLYTIC CAPACITOR, 5x11mm RM2	4u7/63V		NIPPON CHEMI-CON	–	YES	YES
C20, C48, C49, C32, C41	3	ELECTROLYTIC CAPACITOR, 10x16mm RM5, SMG	220M/63V		NIPPON CHEMI-CON		YES	YES
C21	1	CERAMIC CAPACITOR, size 1206, X7R, 50V,	22n	20%	various		YES	YES
C22, C24, C7	2	CERAMIC CAPACITOR, size 1206, X7R, 50V,	NU	20%	various		YES	YES
C25	1	CERAMIC CAPACITOR, size 1206, X7R, 50V,	1uF	20%	various		YES	YES
C26, C37	2	CERAMIC CAPACITOR, size 1206, X7R, 50V,	100p	20%	various		YES	YES
C29, C44	2	CERAMIC CAPACITOR, size 1206, X7R, 50V,	220p	20%	various		YES	YES
C3	1	CAPACITOR R46X, MKP, 0.47uF/275Vac, RM22.5	470nF/275Vac		ARCOTRONICS	R46 KI 3470 –N0 M	YES	YES
C33, C36, C50	2	CERAMIC CAPACITOR, size 1206, X7R, 50V,	10n	20%	various		YES	YES
C34	1	ELECTROLYTIC CAPACITOR, 6.3x11mm RM2.5, SMG	10uF/100V		NIPPON CHEMI-CON		YES	YES
C35	1	ELECTROLYTIC CAPACITOR, 6.3x11mm RM2.5, SMG	100uF/35V		NIPPON CHEMI-CON		YES	YES
C38	1	CAPACITOR R76, MMKP, 0.010uF/400Vdc, RM7.5	0.010uF/400Vdc		ARCOTRONICS	R76MD2100—3-K	YES	YES
C4, C51	1		100uF/450V				YES	YES
C43	1	CERAMIC CAPACITOR, size 1206, X7R, 50V,	1uF	20%	various		YES	YES
C5, C15, C16, C17, C18, C19, C27, C39, C40, C47	8	ELECTROLYTIC CAPACITOR, 10x16mm RM5, SMG	470M/35V		NIPPON CHEMI-CON		YES	YES
C8, C12, C28, C30, C42, C45, C46	7	CERAMIC CAPACITOR, size 1206, X7R, 50V,	100n	20%	various	–	YES	YES
C9, C11, C23, C31	4	CERAMIC CAPACITOR, size 1206, X7R, 50V,	1n	20%	various	–	YES	YES
CY1, CY2, CY3	3	CAPACITOR R41Y, MKP, 2200pF/300Vac, RM10	2n2/Y1		ARCOTRONICS	R413F 1220 – 00M	YES	YES
D1	1	15A, 600V Soft Recovery Power Rectifier	MSR1560G		ON Semiconductor		NO	YES

D10, D11, D17	3	Surface Mount Ultrafast Power Rectifier	MURA160T3G		ON Semiconductor		NO	YES
D12	1	3A 40V Schottky Rectifier	MBRS340T3G		ON Semiconductor		NO	YES
D13	1	Zener diode 0.5W	MMSZ16ET1G		ON Semiconductor		NO	YES
D14	1	Surface Mount Si-Rectifiers	SM5408		various		YES	YES
D15, D16	2	Switching diode	MMSD914G		ON Semiconductor		NO	YES
D2	1	20A 100V Dual Schottky Rectifier	MBRF20100CTG		ON Semiconductor		NO	YES
D3, D4, D5, D6, D7, D18	6		MBRS4201T3G				NO	YES
D8	1	Zener diode 0.5W	MMSZ7V5ET1G		ON Semiconductor		NO	YES
D9	1	Switching diode	NU		ON Semiconductor		YES	YES
F1	1	FUSE HOLDER grid 22,5mm, isolated cap OGN0031 8201	T-4A		Schurter (Buerklin)		YES	YES
IC1	1	Compact Fixed-Frequency Current-Mode Power Factor Correction Controller	NCP1653DR2G		ON Semiconductor		NO	YES
IC2, IC5	2	Voltage regulator	TL431AIDR2G		ON Semiconductor		NO	YES
IC3	1	High Performance Resonant Mode Controller	NCP1395ADR2G		ON Semiconductor		NO	YES
IC4	1	High−Voltage Switcher for Medium Power Offline SMPS	NCP1027P065G		ON Semiconductor		NO	YES
IC6, IC7, IC8	3	Optocoupler	PC817		various		NO	YES
IC9	1	High and low side Power MOSFET Driver	NCP5181DR2G		ON Semiconductor		NO	YES
J1	1	2 PIN CONECTOR	MOLEX 2PIN		MOLEX		YES	YES
J2	1	MOLEX connector, part no. 22-23-2101	22-23-2101		MOLEX	22-23-2101	YES	YES
J3	1	MOLEX connector, part no. 22-23-2051	22-23-2051		MOLEX	22-23-2051	YES	YES
J4, J5	2						YES	YES
L1, L2	2	MAINS FILTER, SPECIFICATION 6001.0069 A	7mH		PULSE	6001.0069 A	NO	YES
L3	1	PFC COIL, SPECIFICATION 2702.0010 A	650uH		PULSE	2702.0010 A	NO	YES
L4, L6, L7, L8	4	CHOKE	2u2/10A		P&V ELEKTRONIC		NO	YES
Q1, Q2, Q3	3	NPN Transistor	BC817-16LT1G		ON Semiconductor		NO	YES
R1	1	VARISTOR, RM7.5	CV275K10B1		various		YES	YES
R10	1	RESISTOR 1206	4k7		various		YES	YES
R11, R12	2	RESISTOR, SIZE 0207	2M2		various		YES	YES
R13	1	RESISTOR 1206	470k		various		YES	YES
R14	1	RESISTOR 1206	56k		various		YES	YES
R15, R16, R70, R72	4	RESISTOR 1206	10k	1%	various		YES	YES
R17, R19, R59	3	RESISTOR 1206	1k		various		YES	YES
R36	1	RESISTOR 1206	1k6, 1%		various		YES	YES
R18	1	RESISTOR 1206	20k, 1%		various		YES	YES
R2	1	THERMISTOR, RM7.5	THERMISTOR-7,5		various		YES	YES
R20	1	RESISTOR 1206	2k7		various		YES	YES
R21	1	RESISTOR 1206	4k3	1%	various		YES	YES

R22	1	RESISTOR 1206	4k7	1%	various		YES	YES
R23, R24, R41, R33, R34	1	RESISTOR 1206	NU	1%	various		YES	YES
R25	1	RESISTOR 1206	100k		various		YES	YES
R26	1	RESISTOR 1206	680k		various		YES	YES
R27, R39	2	RESISTOR 1206	330k		various		YES	YES
R28	1	RESISTOR 1206	150k		various		YES	YES
R29	1	RESISTOR 1206	6k2		various		YES	YES
R3	1	SENSE RESISTOR, SIZE 0617	0.1R		various		YES	YES
R31, R32, R52	3	RESISTOR 1206	1M		various		YES	YES
R35	1	RESISTOR, SIZE 0207	820R		various		YES	YES
R37	1	RESISTOR 1206	200k		various		YES	YES
R38, R65, R67	1	RESISTOR 1206	0R		various		YES	YES
R4, R48	2	RESISTOR 1206	10k		various		YES	YES
R40, R53, R54	3	RESISTOR 1206	1M2		various		YES	YES
R42	1	RESISTOR 1206	33k		various		YES	YES
R43	1	RESISTOR 1206	5k6		various		YES	YES
R44	1	RESISTOR 1206	2k7		various		YES	YES
R45, R58	1	RESISTOR 1206	100R		various		YES	YES
R46	1	RESISTOR 1206	2k2		various		YES	YES
R47	1	RESISTOR, SIZE 0414	4M7		various		YES	YES
R49	1	RESISTOR 1206	18k	1%	various		YES	YES
R5, R30	2	RESISTOR 1206	470k		various		YES	YES
R50	1	RESISTOR 1206	3k9		various		YES	YES
R51	1	RESISTOR 1206	75k		various		YES	YES
R55	1	RESISTOR 1206	330k		various		YES	YES
R56	1	RESISTOR, SIZE 0207	47R		various		YES	YES
R57	1	RESISTOR, SIZE 0411	150k / 0.5W		various		YES	YES
R6, R7	2	RESISTOR 1206	750k		various		YES	YES
R60, R61	2	RESISTOR 1206	10k	1%	various		YES	YES
R62	1	RESISTOR 1206	470R		various		YES	YES
R63	1	RESISTOR 1206	2k		various		YES	YES
R64	1	RESISTOR 1206	47k		various		YES	YES
R66	1	RESISTOR 1206	18R		various		YES	YES
R68	1	RESISTOR 1206	4k7		various		YES	YES
R69, R71	2	RESISTOR 1206	10R		various		YES	YES
R8	1	RESISTOR 1206	4R7		various		YES	YES
R9	1	RESISTOR 1206	11k		various		YES	YES
T1	1	MDmesh™ MOSFET	STP20NM60FP		ST Microelectronics		YES	YES
T2, T3	2	Zener-Protected SuperMESH™MOSFET	STP12NM50FP		ST Microelectronics		YES	YES
TR1	1	MAIN SWITCH MODE TRANSFORMER SPECIFICATION, CODE : 2652.0017A	2652.0017A		Pulse	2652.0017A	NO	YES
TR3	1	SWITCH MODE TRANSFORMER SPECIFICATION, CODE : 2362.0031 A	2362.0031A		Pulse	2362.0031 A	NO	YES

	1	AL cooler	SK454 - 150mm		FISHER elektronik			
	1	AL cooler	SK454 - 100mm		FISHER elektronik			

12 Appendix

12.1 NCP1395

- Datasheet
- AND8255: A Simple DC SPICE Model for the LLC Converter
- AND8257: Implementing a Medium Power AC-DC Converter with the NCP1395

12.2 NCP5181

- Datasheet
- AND8244: A 36 W Ballast Application with the NCP5181

12.3 NCP1653

- Datasheet
- AND8184: Four Key Steps to Design a Continuous Conduction Mode PFC Stage Using the NCP1653
- AND8185: 300 W, Wide Mains, PFC Stage Driven by the NCP1653
- NCP1653 PFC Boost Design Worksheet

12.4 NCP1027

- Datasheet
- AND8241: A 5 V/2 A Standby Power Supply for Intel Compliant ATX Applications
- NCP1027 Brownout Computing

12.5 References

Draft Commission Communication on Policy Instruments to Reduce Stand-by Losses of Consumer Electronic Equipment (19 February 1999)

- http://energyefficiency.jrc.cec.eu.int/pdf/consumer_electronics_communication.pdf

European Information & Communications Technology Industry Association

- http://www.eicta.org/
- http://standby.lbl.gov/ACEEE/StandbyPaper.pdf

CECP (China):

- http://www.cecp.org.cn/englishhtml/index.asp

Energy Saving (Korea)

- http://weng.kemco.or.kr/efficiency/english/main.html#

Top Runner (Japan):

- http://www.eccj.or.jp/top_runner/index.html

EU Eco-label (Europe):

- http://europa.eu.int/comm/environment/ecolabel/index_en.htm
- http://europa.eu.int/comm/environment/ecolabel/product/pg_television_en.htm

EU Code of Conduct (Europe):

- http://energyefficiency.jrc.cec.eu.int/html/standby_initiative.htm

GEEA (Europe):

- http://www.efficient-appliances.org/
- http://www.efficient-appliances.org/Criteria.htm

Energy Star:

- http://www.energystar.gov/
- http://www.energystar.gov/index.cfm?c=product_specs.pt_product_specs

1 Watt Executive Order:

- http://oahu.lbl.gov/
- http://oahu.lbl.gov/level_summary.html