



Enables high efficiency at all load levels

## NXP TEA2016/TEA2095 ICs

NXP's TEA2016 and TEA2095 ICs provide reliable power supply design and help make LLC design easier. Built to NXP Greenchip® program standards, this platform offers high efficiency and very low no-load power.

### KEY FEATURES

#### TEA2016 PFC + LLC Resonant Controller

- ▶ Complete functionality of LLC and PFC controller in single small-size SO16 package
- ▶ Integrated high-voltage start-up
- ▶ Integrated drivers and high-voltage level shifter (LS)
- ▶ High-side driver directly supplied from the low-side driver output (patent number 82059363US01)
- ▶ Accurate boost voltage regulation
- ▶ Integrated X-capacitor discharge without additional external components
- ▶ Power good function
- ▶ Extensive MTP programmability to help optimize performance:
  - Many burst mode settings to help ensure lowest audible noise, highest efficiency and lowest output ripple
  - Flexible configuration of protection functions, e.g., a programmable number of restarts before a latched protection occurs
  - Easy design optimization in a live application by means of setting parameters via a GUI; helps designer meet requirements during development

#### TEA2095 Dual LLC Resonant SR Controller

- ▶ Adaptive gate drive
- ▶ No-load supply current < 100  $\mu$ A
- ▶ Wide supply voltage range (4.5 to 38 V)
- ▶ Switching frequency up to 1 MHz
- ▶ No minimum on-time, no reverse current

- ▶ 25 mV regulation level to support low  $R_{ds(on)}$  MOSFETs
- ▶ Enabling lower  $V_{ds}$  MOSFETs (lower spikes)
- ▶ Automatic output discharge function included
- ▶ SO8 package and SO8 package with exposed leadframe

### APPLICATIONS

- ▶ Desktop and all-in-one PCs
- ▶ Gaming consoles
- ▶ TV power supplies (Ultra HD, 4K)
- ▶ Notebook adapters
- ▶ Lighting applications up to 350 W

The TEA2016/TEA2095 IC combination helps ease the design process of a highly efficient reliable power supply, supporting 90 W to 500 W with a minimum of external components. The system provides a very low no-load input power (< 75 mW; total system including the TEA2016/TEA2095 combination) and high efficiency from minimum to maximum load.

This new platform builds on a familiar format: the TEA1916 LLC resonant topology. It also uses synchronous rectifier (SR) control with adaptive gate drive, without minimum on-time and without reverse current, so the overall system guarantees increased efficiency over the entire load range. The new LLC platform also delivers excellent performance at low standby power, even without an auxiliary power supply, so it complies with new regulations while also reducing system cost.



Two features from the previous TEA1916 series make the LLC platform an advance over previous topologies: variable operating modes and cycle-by-cycle capacitive voltage (VCAP) control.

### VARIABLE MODES

Three operating modes—burst, low power and high power—make it possible to automatically select the best mode for each combination of power and control voltage, resulting in higher efficiency. The burst and low-power modes operate at lower loads and use switching frequencies that are outside the audible spectrum, thus generating less acoustic noise.

### CYCLE-BY-CYCLE CONTROL

The traditional approach to frequency control can be difficult to manage, since it involves high gain in the control loop, meaning even small deviations in the frequency can produce much higher output power. To make things simpler, the new NXP LLC platform keeps using a cycle-by-cycle architecture that regulates the output voltage ( $V_{OUT}$ ) using the capacitance voltage ( $V_{Cr}$ ) of the LLC resonant tank. The main advantage of this approach is that  $V_{Cr}$  is linear related to output power.

The cycle-by-cycle architecture enables the low-power mode, which the user can also see as a high-frequency burst mode. This mode is active between the burst and high-power modes.

This architecture also increases the efficiency of burst mode and makes it possible to activate the burst and low-power modes at a specified output power.

### TEA2016 PFC + RESONANT CONTROLLER

The TEA2016 is a digital configurable LLC and PFC combo controller for high-efficiency resonant power supplies. It includes both the LLC controller functionality and PFC controller operating in DCM and QR mode. The TEA2016 controller enables building a complete resonant power supply that is easy to design and has a very low component count.

The TEA2016 digital architecture is based on a high-speed configurable hardware state machine ensuring reliable real-time performance. During the power supply development, many operation and protection settings of the LLC and PFC controller can be adjusted by loading new settings into the device to meet specific application requirements. The user can easily program an extensive number of IC

parameters via a user-friendly GUI in a live operating power supply.

The TEA2016 IC contains all protections such as overtemperature protection (OTP), overcurrent protection (OCP), overvoltage protection (OVP), overpower projection (OPP), open-loop protection (OLP), and capacitive mode regulation (CMR). Programming parameters inside the device can configure each of these protections independently and accurately.

### TEA2095 DUAL SR CONTROLLER

The TEA2095 is a dual SR controller optimized for resonant (LLC) power supplies. Its adaptive gate control at low and high loads produces high efficiency over the entire load range. The TEA2095 IC can be used with a wide range of supply voltages, for operation from 4.5 to 38 V where the output is automatically discharged after a mains brown-out is detected. The TEA2095T and TEA2095TE support switching frequencies up to 1 MHz.

### NXP GREENCHIP® SOLUTIONS

The NXP GreenChip power solutions portfolio enables smarter, more compact energy-efficient power solutions. Complete GreenChip system solutions help optimize applications such as highly efficient power supplies and system protection.

## TEA2016 + TEA2095 APPLICATION DIAGRAM

