FFX
Full flexible amplification
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The world’s highest efficiency class-D amplifiers enabling audio application convergence

STMicroelectronics takes a step forward in the audio digital domain, enlarging the Sound Terminal™ product family already widely successful in all the traditional consumer electronics market segments (LCD and PDP TVs, audio for portable devices, home systems and set-top boxes). The new STA369BWS mainly addresses the emerging LED backlit ultrathin flat panel TVs.

The devices are built around the FFX controller, a powerful and flexible solution capable of handling both analog and digital sources, delivering a very efficient digital stream to the speakers with audiophile quality sound.

FFX, a proprietary technology belonging to STMicroelectronics, uses an all-digital approach that combines an FFX controller and a digitally-controlled power component on a single device. Binary, ternary and phase-shifting modulation can be set according to each application requirement. The single-package solution allows both cost optimization and design simplification.

KEY FEATURES
• Up to 94% efficiency (portable applications)
• Fully flexible amplification
• Binary modulation
• Phase shift modulation
• Ternary modulation
• Binary capacitor-less (portable applications)
• Unrivaled audio quality at maximum dynamic
• Patented digital pop-free start-up
• Analog and digital input
• Microcontroller-less configuration
• Multiband DRC (B²DRC)
• Equalized DRC (EqDRC)

TARGETED APPLICATION
• Portable and personal systems
• Audio home systems
• Set-top boxes
• Flat panel TVs
• Home systems

PRODUCT SELECTION TABLES
HOME SYSTEM, MINI/MICRO HI-FIS, DOCKING STATIONS
Convergence is a key word for the consumer market.
New systems must be able to handle any source - from analog to digital - and to provide entertainment functions such as karaoke.
ST’s FFX technology enables seamless connection to any source and embeds DSP features, delivering the most appealing audio effects.

### KEY FEATURES
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### KEY BENEFITS
- Product form factor
- Selectable PWM modulation for configurable products (headphone direct drive, up to 400 W per channel speaker driving)
- Best listening experience
- Seamless connection to any source
- As easy as analog solutions
- BOM reduction

### TARGETED APPLICATION
- Portable and personal systems
- Audio home systems
- Set-top boxes
- Flat panel TVs
- Home systems

### TARGETED APPLICATION

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
<th>Supply voltage (V)</th>
<th>DSP</th>
<th>Input</th>
<th>Microcontroller</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>STA323W</td>
<td>2.0/2.1 2 x 20 W/2 x 10 W + 1 x 20 W</td>
<td>8 to 36</td>
<td>4 biquads/channel</td>
<td>Digital</td>
<td>No</td>
<td>PSSO36</td>
</tr>
<tr>
<td>STA330WS</td>
<td>2.0, 2 x 10 W</td>
<td>4.5 to 20</td>
<td>Volume control</td>
<td>Digital</td>
<td>No</td>
<td>CSP 5 x 6</td>
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<td>STA330WSML</td>
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<td>4.5 to 18</td>
<td>Gain selection</td>
<td>Digital</td>
<td>Yes</td>
<td>CSP 5 x 6</td>
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<td>STA309BW</td>
<td>2.0 + headphone out/2.1 2 x 10 W/2 x 10 W</td>
<td>5 to 26</td>
<td>8 biquads/channel multiband + EqDRC</td>
<td>Digital</td>
<td>No</td>
<td>PSS036</td>
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<tr>
<td>STA309BWS</td>
<td>2.0 + headphone out/2.1 2 x 10 W/2 x 10 W</td>
<td>4.5 to 21.5</td>
<td>8 biquads/channel multiband + EqDRC</td>
<td>Digital</td>
<td>No</td>
<td>PSS036</td>
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<tr>
<td>STA350BW</td>
<td>2.0</td>
<td>2 x 50 W/2 x 18 W</td>
<td>5 to 26</td>
<td>8 biquads/channel multiband + EqDRC</td>
<td>Digital</td>
<td>No</td>
</tr>
<tr>
<td>STA355BW</td>
<td>2.0 + headphone out/2.1 2 x 10 W/2 x 5 W + 1 x 20 W</td>
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<td>8 biquads/channel multiband + EqDRC</td>
<td>Digital</td>
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<td>PSS036</td>
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<tr>
<td>STA759BWS</td>
<td>2.0 + headphone out/2.1 2 x 10 W/2 x 10 W + 1 x 20 W</td>
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<td>8 biquads/channel multiband + EqDRC</td>
<td>Digital</td>
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<td>STA769BW</td>
<td>2.0 + headphone out/2.1 2 x 10 W/2 x 5 W + 1 x 20 W</td>
<td>4.5 to 16</td>
<td>4 biquads/channel</td>
<td>Digital</td>
<td>No</td>
<td>PSS036</td>
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</tbody>
</table>
| STA529 | Analog-to-digital converter with headphone output and microphone input | 1.8 to 3.6 | Analog in and digital in maing capability | Analog/ digital | Yes | TFBGA48 VFQFPN62
## TV

ST has a long tradition of successful products for TV applications, and is now introducing the STA369BWS to meet the challenging demands of ultra-thin LED TVs. Integration, audio quality and features are the foundations of ST’s market leadership.

### SET-TOP-BOXES

ST’s home entertainment capabilities span the complete spectrum of software and hardware, from the latest video-processing algorithms to the industry’s most advanced SoC devices, embedding best-in-class security and connectivity. In this context, audio and IC connection must be as easy as possible. ST audio ICs are designed to meet the needs for turnkey solutions and format change required by the set-top box market.

### PORTABLE APPLICATIONS

The FFX cell is designed to handle the most demanding portable and personal applications in the consumer and professional audio markets, as well as digital still cameras (DSC).

The FFX portable codec can drive from 100 mW to more than 1 W per channel just by changing the output load from 32 to 4 ohms: the audio quality is kept constant using a dedicated PWM modulation scheme. The FFX filterless application guarantees the best form factor for final products.

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### Part number Description Supply voltage (V) DSP Input Microcontroller less Package

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</thead>
<tbody>
<tr>
<td>STA320W</td>
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<td>STA333ML</td>
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<tr>
<td>STA339BW</td>
<td>2.0 + headphone out/2.1</td>
<td>4 biquads/channel</td>
<td>Digital</td>
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<td>STA339BW</td>
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For further information on the ST audio product family, please contact: eur.audio@st.com or visit www.st.com/audio
FFX class architecture is a digital low-distortion, low-noise PCM-to-PWM converter, based on a new sample reconstruction approach which converts the digital input signal into a differential pulse-width modulated signal at the frequency of 384 kHz and with a time resolution of 100 MHz.

To avoid distortion and spurious harmonics generation, the audio signal is oversampled (1), and linearized, then an exact calculation of the intersection between the resulting piecewise linear signal and up/down carrier signal is performed (2). FFX contains pop-free start-up, STMicroelectronics patented fully-digital pop-noise remover (3). The result is obtained gradually, loading the output capacitor from zero to half the supply with the PWM signal, starting from near 0% duty cycle to 50% duty cycle (4).

ST pop-free start-up is thus faster than the traditional resistive partition method.

FFX can release an unrivaled signal-to-noise ratio. FFX for portable applications can work either with an output reconstruction filter or in filter-less mode.

FFX contains specific modulation, called binary headphone, which delivers a headphone capacitor-less solution.

FFX based products contain an analog-to-digital converter and muxing features. The ADC is specifically designed to match the FFX cell and to keep the overall chain quality unchanged. This step of integration allows FFX users to save cost, reduce IC count and design unconstrained form factor products.
In modern audio systems, the loudspeaker has become the weakest link in the audio amplification chain, both in terms of performances and sound efficiency. This is all the more so in the latest generation of flat-panel TVs with LED backlighting, where the overall thickness is further reduced. Loudspeakers used in such systems, as well as in other miniaturized handheld sound equipment such as PMPs and smartphones, require state-of-the-art protection technology. This is what STSpeakerSafe is for.

STSpeakerSafe squeezes the best sound quality and power from any loudspeaker under the safest of conditions, thus preventing speaker damage and preserving its original performances over time. STSpeakerSafe includes the latest advanced technology for thermal, overcurrent or overvoltage protection. It can precisely limit the delivered power in the different frequency ranges with a multiband dynamic range compressor. Moreover, self-diagnostic and auto-protection systems prevent any DC signal from damaging the loudspeaker, and immediately warn the host system about any abnormal condition.

ST’s proprietary FFX technology is among the most efficient and successful IPs ever produced for digital audio amplification. Its highly sophisticated and advanced design has now been further improved to reduce the size of the external filtering circuitry (choke and capacitors), resulting in a reduced overall solution size and cost.

In its full-fledged implementation, the company proprietary spread spectrum modulation (SSM) is used. Combined with the unique ternary modulation, this delivers unprecedented efficiency in full filterless configuration, still complying with the most stringent EMI requirements. A lighter version, already available in the STA369BWS top performance device, is capable of digitally filtering the PWM carrier, thus simplifying external filtering requirements. This solution is specifically designed for applications where a simple op-amp can be used, for instance, to drive an auxiliary headphone line.

**Sound Terminal™ : F³X™ High-efficiency digital class-D modulator**

- **FFX™ PWM modulator**
- **Digital filter**
- **Power bridge**
- **Spread spectrum controller**
- **Control logic**
- **Power bridge**
- **Filterless output**

**STSpeakerSafe™ technology**

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**Sound Terminal™**

- **STSpeakerSafe™ control logic**
  - Coefficient fault detection
  - DC detection
  - Modulator fault detector
  - PWM fault detector
  - FFX™ PWM modulator
  - Thermal, overcurrent and short-circuit protection

- **Run-time checksum engine**
- **EQ coefficient bank**
- **Auto-recovery**
- **FFX™ SpeakeIR compensation and parametric equalizer**
- **Volume control**
- **Multiband DRC**
- **DC detector**
- **Reporting link**
- **Control link**
In some applications, where space, or costing constraints are significant, the loudspeaker systems are often unable to reproduce the whole audio frequency spectrum with good performance. A good example of an application where both speaker size and cost are being squeezed is flat-screen televisions.

Multiband dynamic range compressor technology, or MDRC, was developed by ST in order to adjust or customize the dynamic range of a signal to a smaller range. This can be accomplished by dynamically controlling a programmable attenuation stage according to the measured average peak level of the signal: the higher the average level, the higher the attenuation. Simply put, this optimizes the audio quality for a given set of speakers, as well as protecting them from output power overstress, which could permanently damage them.

MDRC allows precise control and limiting of the delivered output power. Different parameters for the low and high frequency bands maintain the sound energy within safe boundaries while maximizing loudspeaker performances. The overall audio quality is greatly improved while avoiding unpleasant masking effects, which typically happen when high-energy, low-frequency sounds overwhelm dialog content.

The Sound Terminal™ family offers three different types of limiters and MDRC processing blocks, thus handling most of today’s demanding audio applications, described in the following sections.

**LIMITER (DRC/ANTI-CLIPPING MODES)**

This functional mode allows the signal to be clipped or limited at a programmable threshold, as shown in Figure 1. The attack and release thresholds can be set, as well as the attack and release rates (dB/ms) and the parameter defining the reference values for the thresholds.

**DUAL-BAND DRC (B²DRC)**

This functional mode allows independent processing of high and low frequency content for each of the two L/R main channels. A single high-pass filter is used to extract the high frequency content. The low frequency part is obtained as a result of the difference between the input signal and its high-pass filtered signal, as shown in Figure 2. There is also a completely independent limiting control on the high and low frequency content.

**EQUALIZED DRC (EqDRC)**

This functional mode corresponds to an improved limiter version which adds a pre-filtering of the signal feeding the attenuation controller. In this way, the threshold level can be shaped with respect to the frequency band. Contrary to B²DRC mode, EqDRC does not process the high and low audio frequencies with 2 independent limiters, but instead customizes the shape of the threshold levels applied by a single attenuator across the entire frequency band.

**MULTIBAND DRC**

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Ongoing technological evolution in the electronics field is allowing increasingly complex functionalities to be built into very small and compact monolithic devices. They are thus ideal for the latest generation of compact home systems, ultrathin flat-panel TVs and miniaturized portable and personal systems.

So as to tune and configure Sound Terminal products in real time, ST proposes a state-of-the-art development environment, APWorkbench, free of charge. APWorkbench is an integrated and easy-to-use professional environment that operates through a dedicated USB interface (APWLink). The highly sophisticated environment offers immediate and intuitive access to the most advanced functionalities of the device, turning complex operations, such as fine tuning of parameters and coefficients, into actions as easy as pressing a button or sketching the desired audio equalization curve on a blackboard.

APWorkbench greatly reduces the learning curve for a new product, so configuring a newly selected device for mass production is just a matter of a few mouse clicks. Listen to the remarkable sound clarity of Sound Terminal devices and change parameters and equalization settings in real time to find your favorite settings.

The tool includes specialized panels and controls to quickly access every single bit of the device: preset memories can be used to store various configurations and retrieve upon request. Configurations can also be exported to ASCII files and relevant C/C++ control code can be generated to ease writing of host microcontroller code.

Support of third-party tools such as Matlab or LinearX allows you to efficiently integrate the Sound Terminal solution into the customer development environment in a seamless scenario. Get the purest natural sound out of every Sound Terminal amplifier and plug it straight away into your audio equipment.

APWorkbench is fully compatible with any PC running Windows® XP, Vista or Windows® 7 OS.

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