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全新高性能移动式APU — CARRIZO

拥有完整异构系统架构（HSA）能力的新一代高性能APU

- 与Carrizo-L共享同一、可扩展的基础架构
- 针对低功耗笔记本/变形本进行优化的全新“挖掘机”核心
- 支持Mantle、DirectX12和双显卡交火的新一代AMD Radeon™ GCN显卡架构
- 在一个晶片上实现APU和南桥的单芯片集成
- 性能和电池续航时间大幅提升，世界首款完整支持HSA1.0的处理器
- AMD安全处理器采用ARM® TrustZone技术，实现企业级的安全特性
加速处理器（APU）实现内在节能

- 将CPU、GPU和多媒体加速器整合在一个晶片上
- APU 专为更佳的能效优化
  - CPU和GPU之间高效、精细的电源管理
  - CPU <-> GPU通信能耗与分离芯片相比大大降低
  - 共享内存接口协助降低能耗

温度分布布局

CPU <-> GPU电源互通
基于异构系统架构（HSA）的AMD APU 能效
CARRIZO旨在设计成为第一款完全兼容异构系统架构的系统级芯片（SOC）

这也对功耗来说有何意义？

- 相比于单独使用CPU，GPU计算资源的使用让许多工作负载的执行更加高效
  - 比如视频索引、自然人机界面和模式识别
- 同样功耗，性能大幅提升：每次操作能耗更低→更佳的功效

PC计算能力趋势

图表展示CPU和GPU性能趋势，以及PCMark7和PCMark8 v2的演进。
具备高密度库设计的、功耗优化的CPU “挖掘机”

“压路机”库执行

“挖掘机”高密度库设计

在同样的28nm技术节点，尺寸减少23%，并且功耗更低

高性能vs高密度单元范例

<table>
<thead>
<tr>
<th></th>
<th>HP库</th>
<th>HD库</th>
</tr>
</thead>
<tbody>
<tr>
<td>浮点调度器</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td>FMAC</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>1缓存控制</td>
<td>35%</td>
<td></td>
</tr>
</tbody>
</table>

上一代以CPU为中心的锥形金属堆叠

以通用GPU为主的堆叠可以实现更高的密度
CARRIZO 低功耗优化图形核心

 Leakage reduction 18% and faster RVT device selection can achieve the same power level, resulting in a 10% increase in frequency, or up to 20% power savings at the same frequency.

28nm device suite

Standardized Ioff

High density device selection
High performance device selection

High voltage device selection

28nm general curve

High density power optimized
High perf legacy design

0.0W
5.0W
10.0W
15.0W
20.0W
25.0W
30.0W
电压自适应运行

- 为高性能CPU、GPU和APU提供低噪电压一直是全行业的挑战
- 发生的波动一般占标称值的10% —— 这意味着至少20%的电力被用于弥补这些电压波动（用电量是电压的平方）
- AMD独特的电压自适应功能可通过在平均电压运行，并在电压降低时，快速降低频率来节省绝大部分被浪费的电力

![电压自适应功能同时应用于Carrizo的CPU和GPU，电量节省分别达19%和10%](image)

自适应时钟电能节省

有电压自适应功能对比没有

<table>
<thead>
<tr>
<th>标准化时钟频率</th>
<th>CPU节能</th>
<th>GPU节能</th>
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</thead>
<tbody>
<tr>
<td>1.15</td>
<td></td>
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<tr>
<td>1.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

电力节省百分比

- CPU节能
- GPU节能

电压自适应功能：
- Vdd供应
- Vdd高于临界值
- 响应时间 < 1 纳秒
- Vdd降至临界值以下
- 运行频率暂时降低
- ~ 5% 频率获益
- 传统临界频率
AVFS使每瓦性能得到优化

- 有效发掘CPU真正的硅速度潜能
  - 包括域对域运算处理（part-to-part processing）、温度和功率输出的效果
  - 在现有功率和温度感应器的基础上增加了电压和频率感应器

- 综合运算、电压和温度允许的区间，可对给定功率或性能水平的最优运行点进行精确设置
  - 综合整个电压/温度运行区间的增强的能效
运行时进入低功率待机状态

S0i3状态可以实现与传统S3状态同样的功率水平，后者被惯称为“待机”，因为进入和退出都要求操作系统干预，所以要花费大量时间。

- 这种状态下几乎所有APU硅都启动电源门控，相关I/O设备都处于低功率状态，促使整个平台功率降到极低的水平。

在功率管理控制下，通过在快速运行时进入这种状态，APU可以在不到1秒的时间实现与待机同样的功率水平。

典型应用条件下更低的平均功耗。
能效的显著提升

2020年长期目标

计算功耗趋势

针对AMD移动平台
能效提升

至少25倍

与1985年效率相比 (1985=1.0)

超过历史趋势70%+

自2000年以后效率增长开始下降

超过历史趋势70%+

自2000年以后效
率增长开始下降

1985年以后历史趋势
2000-2009年历史功耗

能量使用下降

同时性能提升

= 效率提升

1946年以后历史趋势
AMD多年来始终专注于开发提高能效的系列知识产权

未来将关注更多的前沿创新，加速提升各产品线能效

通过DVFS进行动态电源跟踪与管理

根据热量管理电源

根据不同平台进行动态热量管理

根据环境与可靠性启动

视频解码加速

视频转码加速

音频加速

帧间电源门控

高级带宽压缩

精密电压平面

精密电源门控

电压自适应频率扩展

各部分自适应电压

每IP自适应电压

专门针对ACPI驱动的工作负载进行优化

动态CPU ↔ GPU 能量共享

智能启动和根据性能进行能量优化

针对工作负载进行能量优化

高能效APU架构整合GPU+CPU和加速器

OpenCL GPU计算移动到通过完整HSA实现编程

“Puma” “Tigris” “Danube” “Llano” “Trinity” “Richland” “Kaveri” “Carrizo”
全新高性能移动式APU — CARRIZO
ISSCC 2015细节披露

为能效和面积效率而优化的28NM X86 APU— 会议环节4.8*

- 高密度库设计，与Kaveri晶片面积相近，但晶体管数量增加29%
  - 31亿个晶体管
- 挖掘机核心：功耗降低40%，晶片面积减少23%，IPC增加5%
- 支持H.265且转码性能比Kaveri提升超过3.5倍
- 设备选择和执行调谐，使得8颗Radeon核心比Kaveri节能20%
- 性能和电池续航时间均实现百分比2位数的增长


2 Typical-use Energy Efficiency as defined by taking the ratio of compute capability as measured by common performance measures such as SpecIntRate, PassMark and PCMark®, divided by typical energy use as defined by ETEC (Typical Energy Consumption for notebook computers) as specified in Energy Star Program Requirements Rev 6.0 10/2013
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