Motorola DSP Solutions

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DSP Standard Products Division
Motorola DSP Solutions

**StarCore 16-Bit**
The industry’s most powerful DSP is optimized for high-level languages. This scalable architecture is the ideal solution for multi-channel and baseband processing applications requiring leading-edge performance combined with leadership code density, power and cost per channel performance.

**563xx 24-Bit**
The 56300 processor is unique in that it is a 24-bit architecture. It offers floating-point performance at fixed-point prices. Taking advantage of the 24-bit architecture, Motorola has developed several devices over the past decade focusing on baseband, audio and networking applications.

**568xx 16-Bit**
The is the industry’s first DSP built from the ground up to handle both control and DSP application as efficiently as stand-alone MCUs or DSPs. This family is ideal for cost-sensitive applications requiring low- to mid-range MIP’s performance. Taking advantage of the core’s hybrid nature, Motorola has developed several devices that include MCU and DSP peripherals to provide complete system-on-a-chip solution for your embedded applications. Key applications include industrial, automotive, telecom or datacom applications.
The MSC8101 – Network DSP

- Industry’s first StarCore-based DSP
  - Integrating the SC140 Core
- Industry’s most powerful network-ready DSP
- Integrating the Communications Processor Module (CPM) from MPC8260 PowerQUICC II™
  - ATM and Fast-Ethernet ready
- Industry’s first 60x bus compatible DSP
  - Integrated 64/32-bit 60x PPC bus interface from MPC8260 PowerQUICC II
- Industry’s first DSP to use copper technology
  - Uses Motorola’s 0.18 micron HiPerMOS 6
MSC8102 – 4 SC140 Cores

- Industry’s Highest Performance DSP
  - Four 300 MHz StarCore SC140 DSP Extended Cores
  - 16 ALUs – 4800 MMACs, 12G RISC MIPS
  - Performance equiv. to a 1.2 GHz SC140 core
- Industry’s largest on-chip SRAM
  - 1.436 MByte (11.488 Mbit)
  - Efficient, multi-level memory hierarchy
- Industry’s Highest I/O Throughput
  - Dual system and local buses
  - Four serial TDM interfaces
- Very Low Power Dissipation in a Small FC-PBGA package
  - 1.6 Watts (estimated)
  - 20 mm x 20 mm package
Alliance Partners for Motorola StarCore

SW Dev. Tools
- Metrowerks
- Green Hills Software
- TASKING
- WindRiver

RTOS
- OSE
- LINEO
- WindRiver

App. SW
- Hughes
- Lake Communications

Simulation Tools
- Mentor Graphics
- Cadence
- Mathematica
- CoWare

Hardware
- Tundra
- Tektronix
- PLX Technology
DSP563xx Family

- Fixed point, 24-bit DSP
- Performance - up to 255 effective MIPS, 150 core MIPS
- Single clock cycle per instruction engine providing a twofold performance increase over Motorola's popular DSP56000 core family
- Enhanced Filter Coprocessor (EFCOP) to boost performance
- Compatible with 56000 family; preserves code investment
- Low Voltage - 1.8/2.5/3.3 core voltages & Low Power - 0.7 mA/MIPS @ 1.8v, 0.9 mA/MIPS at 2.5v
- On-chip memory - up to 128K words (24-bit)
- Instruction Cache - 1K word cache minimizes effect of external memory
- Powerful Peripherals - Reduce need for external logic, all trigger DMAs

Applications

- INTERNET PROTOCOL TELEPHONY
- WIRELESS LOCAL LOOP
- GSM
- VOICE/DATA/FAX
- MULTI-CHANNEL COMMUNICATIONS
- VIDEO CONFERENCING
- ADSL/G.Lite
- GENERAL PURPOSE

Price Range

$20 - $90

Parts

DSP56301
DSP56303
DSP56307
DSP56309
DSP56311
DSP5636x Family

• Fixed point, 24-bit DSP
• 100 - 120 MIPS
• Single clock cycle per instruction DSP56300 core
• Enhanced Filter Coprocessor (EFCOP) to boost performance
• Low power with Stop modes
• Code compatible with DSP56000 family
• Audio specific peripherals: Enhanced Serial Audio Interface (ESAI), Serial Host Interface (SHI), Triple Timer, Byte-wide parallel Host Interface (HDI08) with DMA support, and on-chip memory

Applications
• CONSUMER AUDIO
• DOLBY DIGITAL/DTS
• DOLBY PRO LOGIC
• VIDEO APPLICATIONS
• MP3/MPEG2
• EQUALIZATION
• SPECTRUM ANALYSIS
• 3-D VIRTUAL SURROUND
• GENERAL PURPOSE

Parts
• DSP56362
• DSP56364
• DSP56366

Price Range
• <$7 - $20
Combined DSP and Controller Functionality

Motorola’s 56800E hybrid architecture addresses both the control functionality of an MCU and the computational power of a DSP.

By integrating the right peripherals and memory options, Motorola is able to address a vast range of embedded solutions.
The Hybrid Advantage

Telecommunications

- Other Functions
- Packet Protocol
- Silence Suppression
- Audio Compression & Decompression
- Echo Cancellation
- DTMF Tone Detection & Generation
- System Services

Industrial Control

- Other Functions
- Power Factor Correction
- Sensorless Algorithms
- PID Control
- System Control

Bandwidth

- Network Protocol
- Network Management
- Telephony Signaling
- Call Processing
- System Services

System Communications

Human Interface

DSP

MCU

DSP

MCU

MOTOROLA

digital dna

intelligence everywhere
56800E Core Architecture

- Up to 200 MIPS-single clock per instructions
- Additional addressing mode for a total of 19
- Interrupt priority levels for total of 5
- EOnCE for real-time hardware debugging
- Program memory address space-4MB
- Data memory address space-32MB
- Increased compiler efficiency
- Deeper Pipelines
- Move operations supporting 8-, 16- and 32-bit data types
- Lower Power Consumption
- Fast Interrupts
56800/56800E Device Roadmap
## 16 Bit Flash Solutions

<table>
<thead>
<tr>
<th></th>
<th>56F801</th>
<th>56F802</th>
<th>56F803</th>
<th>56F805</th>
<th>56F807</th>
<th>56F826</th>
<th>56F827</th>
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<tr>
<td><strong>Performance</strong></td>
<td>40 MIPS</td>
<td>40 MIPS</td>
<td>40 MIPS</td>
<td>40 MIPS</td>
<td>40 MIPS</td>
<td>40 MIPS</td>
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<td>-40°C, 85°C</td>
<td>-40°C, 85°C</td>
<td>-40°C, 85°C</td>
<td>-40°C, 85°C</td>
<td>3.3V/2.5V dual supply</td>
<td>-40°C, 85°C</td>
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<td><strong>Voltage</strong></td>
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<td>3.3V</td>
<td>3.3V</td>
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<td>3.3V/2.5V dual supply</td>
<td>3.3V/2.5V dual supply</td>
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<td><strong>Program Flash</strong></td>
<td>8K x 16</td>
<td>8K x 16</td>
<td>32K x 16</td>
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<td>60K x 16</td>
<td>32K x 16</td>
<td>Via Program Flash</td>
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<td><strong>Program RAM</strong></td>
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<td>1K x 16</td>
<td>512 x 16</td>
<td>512 x 16</td>
<td>2K x 16</td>
<td>512 x 16</td>
<td>1K x 16</td>
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<td><strong>Data Flash</strong></td>
<td>2K x 16</td>
<td>2K x 16</td>
<td>4K x 16</td>
<td>4K x 16</td>
<td>8K x 16</td>
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<td>2K x 16</td>
<td>2K x 16</td>
<td>4K x 16</td>
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<td>2K x 16</td>
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<tr>
<td><strong>Quad Timers</strong></td>
<td>1x</td>
<td>1x</td>
<td>2x</td>
<td>4x</td>
<td>4x</td>
<td>1x</td>
<td>1x</td>
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<td><strong>GPIO</strong></td>
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<td>4</td>
<td>16</td>
<td>32</td>
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<td><strong>Interrupt Controller</strong></td>
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<td><strong>Pulse Width Modulator</strong></td>
<td>6 Channels</td>
<td>6 Channels</td>
<td>6 Channels</td>
<td>2-6 Channels</td>
<td>2-6 Channels</td>
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<td><strong>CAN 2.0B Module</strong></td>
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<td><strong>A/D Converter</strong></td>
<td>2 x 4 x 12-bit</td>
<td>5 Ch, 12-bit</td>
<td>2 x 4 x 12-bit</td>
<td>2 x 4 x 12-bit</td>
<td>4 x 4 x 12-bit</td>
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<td>10 x 12-bit</td>
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<td><strong>Quadrate Decoder</strong></td>
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<td>1x</td>
<td>2x</td>
<td>2x</td>
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<tr>
<td><strong>External Memory Interface</strong></td>
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<td><strong>JTAGE/OnCE</strong></td>
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<td><strong>Packages</strong></td>
<td>48pin LQFP</td>
<td>32pin LQFP</td>
<td>100pin LQFP</td>
<td>144pin LQFP</td>
<td>160pin LQFP &amp; 160 MBGA</td>
<td>100pin LQFP</td>
<td>128pin LQFP</td>
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Application Examples

- Feature Phones
- Remote Monitoring
- Magnetic Card Readers
- Noise Cancellation
- ID Tag Readers
- Compressors
- Smart Appliances
- Handheld Devices
- Home Security
- Internet Appliances
- Engine management
- Factory Automation
- Digital Speakers
- Seat Module Control
- Digital Answering

- HVAC Blowers & Fans
- Lifts / Elevators / Cranes
- Telecom Test Equipment
- Voice Recognition Systems
- Uninterruptible Power Supplies
- Underwater Acoustics
- Printers / Fax Machines
- Exercise Equipment
- Electric Lawn Equipment
- Temperature Control
- Fuel Management Systems
- Traffic Light Control
Sample 56F8xx Application

3-Phase, AC Induction Motor – Industrial Compressor Drive
Using Direct Torque Control with Over Temperature and Over Pressure Sensing

- DSP568xx
- Motor Drive
- Over Pressure Sensor
- Over Temperature Sensor
- Current Sense
- Voltage Sense
- Compressor
- PWM Outputs
- Fault Inputs
- A/D
- Vdc
- ia
- ib
- Compressor
Stepper Control Topology

- **PWM A**
- **PWM B**
- **Timer A**
- **Timer B**
- **Timer C**
- **Timer D**
- **56F805**

- 4 PWMs with deadtime
- 2 PWMs for DAC functions
- 2 fault inputs for cycle-by-cycle current limiting
- 2 quadrature signals with synthesized dead-time
- Allegro (A3959)
- Allegro (A3959)

40 MHz clock
**Power Line Modems introduction**

- **Basic technical specifications:**
  - low cost low speed solution
  - based on the Motorola DSP56F80x
  - FSK modulation used in CELENEC EN 50065-1 “B” band (95-125kHz)
  - transparent channel operation
  - half-duplex mode of communication
PLM – DSP56F801 Solution
Advantages of software solution

• lower price
• more flexibility (for example, in carrier frequencies selection)
• easier to modify the algorithm for the communication in another CENELEC band or porting to another processor
• more robust communication thanks to digital data processing
## 56800E Improvements

<table>
<thead>
<tr>
<th></th>
<th>MIPS</th>
<th>Clocks Per Instr</th>
<th># Interrupt Levels</th>
<th>Registers</th>
<th>Data Types</th>
<th>Program Memory Address Space</th>
<th>Data Memory Address Space</th>
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<tr>
<td>DSP56800</td>
<td>40</td>
<td>2</td>
<td>2</td>
<td>5 Data</td>
<td>16-bit</td>
<td>128 KB</td>
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<td></td>
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<td></td>
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<td>5 Address</td>
<td></td>
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<tr>
<td>DSP56800E</td>
<td>Up to 200</td>
<td>1</td>
<td>5</td>
<td>7 Data</td>
<td>8-bit, 16-bit, 32-bit</td>
<td>4 MB</td>
<td>32 MB</td>
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<td></td>
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<td>8 Address</td>
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## 56800E 120 MIPS Solutions

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<tr>
<th></th>
<th>56852</th>
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<th>56857</th>
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<tr>
<td>Program RAM (K words)</td>
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<td>12</td>
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<td>24</td>
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<td>Data RAM (K words)</td>
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<td>16</td>
<td>24</td>
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<td>1</td>
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<td>1</td>
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<tr>
<td>Quad Timers</td>
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<td>4</td>
<td>4</td>
<td>1</td>
<td>4</td>
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<td>SPI</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
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</tr>
<tr>
<td>SSI</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<tr>
<td>ESSI</td>
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<td>2</td>
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<td>SCI/UART</td>
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<tr>
<td>Host Interface</td>
<td>8 bit</td>
<td>8 bit</td>
<td>8 bit</td>
<td>8 bit</td>
<td>8 bit</td>
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<td>DMA</td>
<td>6CH</td>
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<td>GPIO (max)</td>
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<td>48</td>
<td>47</td>
<td>48</td>
<td>48</td>
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<tr>
<td>Package</td>
<td>81 MBGA</td>
<td>128 LQFP</td>
<td>128 LQFP</td>
<td>100 LQFP</td>
<td>100 LQFP</td>
<td>144 MGALQFP</td>
</tr>
</tbody>
</table>

### All Devices
- **Technology**: 0.18u
- **Operating Temp Range**: -40°C to 85°C
- **I/O Voltage**: 3.3V
- **Internal Voltage**: 1.8V
- **Data Bus Width X1 (bits)**: 32
- **Data Bus Width X2 (bits)**: 16
- **Instruction Bus (bits)**: 21
- **Program/Data (words)**: 2M/4M
- **JTAG/Eonce**: X
DSP56858 Block Diagram

Features:
- Harvard architecture permits up to three simultaneous accesses to program and data memory.
- On-Chip Memory includes:
  - 40K x 16-bit Program RAM
  - 24K x 16-bit Data RAM
  - 1K x 16-bit Boot ROM
  - Off-Chip Memory Expansion (EMI)
  - Chip Select Logic for glueless interface to ROM and SRAM
- External Memory Expansion
  - up to 2M Program
  - up to 8M Data
- General Purpose 16-bit Quad Timer*
- Two Serial Communication Interface (SCI)*
- Serial Peripheral Interface (SPI) Port*
- Two Enhanced Synchronous Serial Interface (ESSI) modules*
- Computer Operation Properly (COP)
- Watchdog Timer
- JTAG/Enhanced On-Chip Emulation (OnCE)
Application Examples

- IP Phone
- Speaker-Feature Phones
- Client-side IP Telephony
- Internet Appliances
- Wireless Speakers
- Voice Recognition Systems & “Hands-free” Car Kits
Speaker Feature Phone

- Includes the 5685x silicon and implements the following features for a single or multi-line application in compliance with the caller ID telecommunications standard SR-3004:
  - Type 1 Caller ID and Visual Message Waiting Indicator
  - Type 2 Call Waiting ID
  - Type 2.5 Call Waiting Deluxe Options
  - Full Duplex Speakerphone with System Optimization Diagnostic Tools
  - Multi-line/VoIP Conference Bridge
  - Adaptive Line and Acoustic Echo Cancellers
  - Extension in Use Detection
  - DTMF Detection/Generation
  - EIA-470B DTMF Dialer
  - Voice Activity Detection -- call progress signal detection
  - Volume/Gain Control
  - Tonal Ringing Generator
  - AT Command/Control Interface

- All Drivers for 5685x peripherals, Codec and DAA
Speaker Feature Phone Components

- Display
- DSP
  - SSI
- Codec
  - CH 1
  - CH 2
  - Hook Control
  - Ring Detection
  - Line Sense
- DAA
- Audio Circuit
- Mic
- Speaker
- Tip & Ring
- Keypad
- Logic
- GPIO
- Memory
- Driver Logic
5685X Application Example

With MCU functionality and DSP processing power combined with a large number of peripherals and I/O, the enhanced 5685x chips offer a single-chip solution for Client-Side IP Phones. The 5685x devices can support all the necessary system components required for an IP phone, including voice-band codec, keypad, and optional LCD. The device can connect via Ethernet or USB transceiver chips to LAN, DAA to Telco, or RF to wireless LAN.
IP Telephony

In the packet network:
- Groups of compressed digital samples from 1 conversation are placed in packets with a packet header.
- No more fixed-bandwidth requirement, so other types of compression besides G.711 can be used.

At the Central Office:
1) Voice, fax, and modem digitally sampled at 8kHz.
2) Samples then compressed using simple G.711 codec to 8 bits per sample.
3) Samples sent serially at a fixed rate of 64 kbps (8k samples per second * 8 bits per sample) through the network. Several connections are multiplexed over a single wire pair by interleaving samples. (Time Division Multiplexing)

Example: 1 Ethernet packet
(several samples of speech for 1 phone)

Example: 1 T1 frame
(1 sample of speech for 24 phones)
System Software Partitioning

Host
- Application
- MGCP
- H.245
- H.225
- RTP
- H.323
- RTCP
- TCP
- UDP
- IP
- MAC / Ethernet
- Network OS

DSP 56800E
- API
- G.711
- G.723.1
- G.726
- G.729 A/B
- DTMF
- Echo Cancellation
- Acoustic Gain Control
- VAD/CNG
- Packet Playout

Host Processor
Network signaling and management

DSP
Voice processing
Client and Client Access Solutions

- **ColdFire With 5685x**
  - Up to 4 Channels of Voice and Protocol Stack
  - High-End Client Applications
  - Adding Voice to our embedded processor solutions

- **MPC8xx With 5685x**
  - 1 to 2 Channels Applications
  - Port Protocol Stack and Voice Processing

- **StarCore**
  - 4 to 24 Channel Applications

- **5685x Single Chip Solution**
- **5685x Two Chip Solution**
- **5685x and MPC8xx or ColdFire**

- **5685x Stand-alone Device**
- **Dual 5685x Devices**
## Integrated Development Environment

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Availability</th>
</tr>
</thead>
</table>
| Integrated Development Environment | Windows-Based Integrated Development Environment (IDE)  
• Metrowerks CodeWarrior for Motorola-DSP | NOW |
| PC-MASTER Visual Analysis Tool | • PC-based analysis tool enables developers to:  
• Graphically display variables  
• Modify variables in real-time  
• Connection between PC & target hardware via RS-232 interface | NOW |
# Integrated Development Environment

<table>
<thead>
<tr>
<th>Component</th>
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</tr>
</thead>
</table>
| Processor Evaluation & Emulation Kits    | • Standard emulation hardware for processor evaluation & programming  
• Multiple evaluation kits allow the developer to choose the optimal price/performance emulation solution.  
• Each DSP evaluation kit includes a trial version of CodeWarrior and Software Development Kit (SDK) | NOW          |
| Software Development Kit (SDK)           | • Self-installing development library provides production worthy drivers, algorithms, and applications  
• Defined API preserves developer’s software investments by enabling portability among architectures | NOW          |
### Sample SDK Components

<table>
<thead>
<tr>
<th>Vocoder</th>
<th>ADC</th>
<th>Quadrature Decoder</th>
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<tbody>
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<td>G.165</td>
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<tr>
<td>G.711</td>
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<td>G.726</td>
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<thead>
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<td>V.42bis</td>
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| Telephony | Quad Timer | Serial/SCI | SIM | SPI | SSI | TOD (Time OF Day) | Drivers for Off-Chip Peripherals on EVMs
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<td>Narrowband Filter Demo</td>
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<td>Data structures (FIFO)</td>
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  - Age of Backlog, Customer Satisfaction

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