Ultra-Reliable MPC574xP MCU (Panther) for Automotive & Industrial Safety Applications
Industrial Automation Market Trends

**Market Trends**

- **Increased connectivity** / Data sharing in order to:
  - Reduce energy consumption
  - Increase response time/system control
  - Reduce down-time
  - High Growth regions driving low cost products
  - Consumer technology adoption for Multi touch and portable display

- Increase **safety and security**
  (Machine safety mandatory in many industrial regions e.g. EU)

**Implications for NXP**

- Increase of **Industrial Ethernet** networks gaining share over fieldbus
- Intelligent motor control to improve **energy efficiency**
- **Industry 4.0**: connected nodes in the smart factory
- Advanced **HMI** solutions

- **NXP SafeAssure™** support for industrial markets
MPC574xP Introduction

**Key Technical Characteristics**

► Multi-core architecture (2x e200z4 up to 200MHz) with local memory (64KB)
► Scalable Embedded Flash (up to 2.5MB) with EE emulation (up to 384KB SRAM)
► **Delayed lock-step architecture**, duplicated periphery, LBIST / MBIST, ADC self test & FCCU for highest safety integrity level (ASIL D, SIL 4 or PL e)
► **Developed according to the ISO 26262** automotive safety norm (derived from generic IEC 61508)
► Option for **extended temperature** up to 165°C Tj

**Integration and Peripherals**

► Maximum **compatibility to previous NXP safety generation** (MPC5643L)
► **Supporting up to 2 motors**
► Inter-processor high speed serial I/F (SIPI)
► SENT I/F for Chassis applications
► **Ethernet** (in BGA package), LIN, CAN & Flexray I/F options
► 4x multi-chip DSPI for ASIC communication

**Target Applications**

► **Safety Critical Domain / Gateway Control** e.g.
  ► Industrial Automation
  ► Building Control
  ► Braking & Stability
  ► DCDC Converter
  ► Medical

**Packages**

► 144LQFP
► 257MAPBGA
Ultra Reliable & Safe Automotive MCUs

Roadmap

<table>
<thead>
<tr>
<th>Performance</th>
<th>Precision</th>
<th>Safety</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>512K - 1.5M</td>
<td>2 - 2.5M</td>
<td>3 - 4M</td>
<td>6 - 8M</td>
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</tbody>
</table>

- **MPC5643L**
  - 2 x 200MHz, PWM

- **MPC567xK**
  - 2 x 200MHz, SPE, Enet, PWM

- **MPC5746R**
  - 2 x 200MHz, eTPU2+

- **MPC574xP**
  - 2 x 200MHz, 1M-2.5M, PWM, Enet

- **MPC5777M**
  - 2 x 300MHz + 200MHz, GTM, Enet, Flexray

- **MPC5777C**
  - 2 x 264MHz, eTPU2, CANFD, Enet

- **CMOS55**
  - 250 to 300MHz
  - 160 to 200MHz
  - 100 to 150MHz
  - 64 to 80MHz

- **CMOS90**

- **Safety Level (ISO 26262 / IEC 61508)**
  - ASIL D / SIL 3
## MPC574xP Family

<table>
<thead>
<tr>
<th>Features</th>
<th>MPC5741P</th>
<th>MPC5742P</th>
<th>MPC5743P</th>
<th>MPC5744P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flash w ECC</strong></td>
<td>1MB</td>
<td>1.5MB</td>
<td>2MB</td>
<td>2.5MB</td>
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<tr>
<td><strong>Core Performance</strong></td>
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<td>2x e200z4 in delayed lock step, up to 200MHz</td>
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<td>Core bus with 32-bit address, 64-bit data and e2eECC</td>
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<td>Local memory data (64kB RAM) with with System MPU for fast context switch</td>
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<tr>
<td><strong>SRAM w ECC</strong></td>
<td>128KB</td>
<td>192KB</td>
<td>256KB</td>
<td>384KB</td>
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<tr>
<td><strong>Safety Integrity Level</strong></td>
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<tr>
<td>Targeting for ASIL D (ISO 26262) / SIL 3 (IEC 61508) / PL e (ISO 13849)</td>
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<td><strong>I / O</strong></td>
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<tr>
<td>3x FlexCAN (64+2x32 message buffers)</td>
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<tr>
<td>1x FlexRay (Dual Channel 64 msg. buffers)</td>
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<td>2x LINFlex (Uart/Lin protocol driver)</td>
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<td>4x DSPI</td>
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<tr>
<td>2x FlexPWM (2 x 12ch for 2 independent Motors Controlled)</td>
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<tr>
<td>3x eTimer modules (18 channel total)</td>
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<td>4x SAR ADC</td>
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<td>2x SENT (2 ch each)</td>
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<tr>
<td>Ethernet (available in MAPBGA package option)</td>
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<tr>
<td><strong>System</strong></td>
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<tr>
<td>Safe DMA</td>
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<tr>
<td>Dual-PLL (Peripheral + System Core)</td>
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<tr>
<td>Temperature Sensor</td>
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<tr>
<td>Fault Collection unit (FCCU)</td>
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<tr>
<td>CRC computing unit</td>
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<tr>
<td>Aurora Nexus debug interface</td>
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<tr>
<td>Interprocessor Serial Link Interface (SIPI) with approx 300Mbaud</td>
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<tr>
<td><strong>Temperature Range</strong></td>
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<tr>
<td>up to 135°C / 165°C (ambient / junction)</td>
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<tr>
<td><strong>Supported Packages</strong></td>
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<tr>
<td>144 LQFP (0.5 mm pitch) / 257 MAPBGA (0.8 mm pitch)</td>
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</table>
MPC574xP Safety Features

More details in MPC5744P Safety Manual
MPC574xP Enablement

**S32 Design Studio IDE – Free open source environment for a quick SW development**
- GNU Compiler Collection
- GNU Debugger

**AUTOSAR MCAL Software support**

**Additional Compilers**
- Green Hills – Multi Integrated Development Environment
- Wind River

**Additional Debuggers**
- Lauterbach
- Green Hills
- iSystem
- Cosmic Software

**HW Development Boards**
- MPC57XXXMB (Motherboard) - available
- Daughter Boards
  - MPC5744P-144DS (144 LQFP Socket) - available
  - MPC5744P-257DS (257 MAPBGA Socket) - available

**Umbrella Sample Availability**
- SPC5744PFK1AMLQ9 (144LQFP package) - available
- SPC5744PGK1AMMM9 (257MAPBGA package) – available in MAY 2016
MPC574xP Summary

► The automotive and industrial industries with its **Industrie4.0 trend (smart & safe factory)** as well as the need for **safe gateway controller in cars** to pave the way for autonomous driving **are increasingly requiring functional safety solutions**

► With the SafeAssure™ Automotive MCUs, NXP implemented a systematic approach to **functional safety that reduces complexity** for manufacturers of functional safety systems
  
  ► **Reduced BOM cost** and **simplified Software development** by creating a redundancy concept based on one single MCU only

► **Key Features**
  
  ► Enables highest level of functional safety (ASIL D / SIL 3)
  ► Powerful Multicore, Power Architecture 200MHz z4 cores
  ► Range of memory and package options for your every application
  ► Industry standard I/F incl. Ethernet
  ► Robust automotive qualified product with extended temperature range (up to 165°C Tj)

► **The NXP SafeAssure™ program with its partners support functional safety solutions** on system level till final certification
Origin of Typical Permanent & Transient MCU Failures

- **70% SRAM Failures (transient)**
  - Alpha radiation from the MCU mold compound
  - Cosmic radiation (20 - 25,000 neutrons per hr & cm²)

- **20% Transistor Failures (transient)**
  - Transistor aging (Time dependent dielectric break down or exceeding transistor gate oxide lifetime)

- **8% Package Failures (permanent)**
  - Wire bond integrity
  - Design Rules

- **2% Die Failures (permanent)**
  - Mask set
  - Limited test coverage during SW- & HW-development
Random Failures & Countermeasures using MPC574xP

Single Point of Failure (SPOF)
Immediate potential to cause a hazard

Latent Failure (LF)
Can aggregate and become dangerous in conjunction with a second fault

Common Cause Failure (CCF)
Causes several components to fail & possibly annul redundancy-based measures

- **Single Point of Failure (SPOF)**
  - Input
  - Component
  - Output

- **Latent Failure (LF)**
  - Input
  - LF Component
  - Output

- **Common Cause Failure (CCF)**
  - Component
  - Output

**NXP-Solution**
- Structural redundancy (replication of Core & DMA)
- Information redundancy (E2E ECC for Memory and Internal Bus Transfers, EDC on Cache)

**NXP-Solution**
- Periodic self test
  - Memory & logic (< 50ms)
  - ADC, register configuration
  - Startup and shutdown LBIST

**NXP-Solution**
- Measures according to IEC 61508
  - Delayed Checker Core
  - Continuous Monitoring of clock, power and temperature
  - Independent safety clock
  - Independent failure signaling
More Integration & Faster Development – NXP has reliable partner which provide safety solutions on system level e.g. using MPC5744P MCU linked to a System Basis Chip (MC33908) and support you through the certification process by taking the latest safety norms into consideration. Refer to NXP partner list.
Fct Safety Motor Control using MPC5744P – Part 2/2

Details

- NXP Component
- External Vendor Component

**Current Sensing Element**
- Signal Conditional Op Amp NE5232N

**Fuji Power Inverter Module**
- PWM Signal

**MPC5744P**
- Cross Bar Switch – E2E ECC (Addr+Data)
- Memory Protection Unit – 32 regions
- PMU SWT
- E200 Dual up to 180 MHz
- PowerPC™ e200 Safety Checker Core
- Debug
- eDMA

**Fault Monitor**
- Safety Watchdog

**Analog Monitor**
- 3.3V
- 5V

**PowerSBC MC33908**
- Analog I/O

**FCCU**
- Flex CAN
- Flex PWM

**GPIO**
- ESD Protection BZA862A
- Suppressor Diodes PTVSSV0Z1U SK

**Monitoring of External IC Errors (Fail-Safe Signal)**
- 12V

**Position Sensor (e.g. Hall Sensor)**
- 12V, 3-phase Motor

**Fail-Safe Switch**
- 12V

**12V, 3-phase Motor**
- MOSFET Predriver MC33GD3000

**PowerPC™ e200 Safety Checker Core**
- 4x ADC
- 16CH each

**Ethernet**
- 384K RAM EEC
- 2.5M Flash EEC

**Lin Flex**
- TSENS
- CTU

**DSPI**
- SENT
- eTimer

**FCCU**
- Flex CAN
- Flex PWM

**GPIO**
- Pressure Sensor MPXH6101A

**Temp. Sensor KTY82/151**

**PowerSBC MC33908**
- V & I Signal

**MPC5744P**
- SPI Signal

**MOSFET Predriver MC33GD3000**
- PWM Signal

**Fault Interrupt**
- Fault Monitor

**Analog I/O**
- 3.3V
- 5V

**PowerSBC MC33908**
- 3.3V

**PowerPC™ e200 Safety Checker Core**
- Debug
- eDMA

**Ethernet**
- 384K RAM EEC
- 2.5M Flash EEC

**Lin Flex**
- TSENS
- CTU

**DSPI**
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- eTimer

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- Flex CAN
- Flex PWM

**GPIO**
- 5V

**Pressure Sensor MPXH6101A**

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- Analog I/O

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- 384K RAM EEC
- 2.5M Flash EEC

**Lin Flex**
- TSENS
- CTU

**DSPI**
- SENT
- eTimer

**FCCU**
- Flex CAN
- Flex PWM

**GPIO**
- 5V
## MPC574xP Document Support

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<th>Type</th>
<th>Purpose</th>
<th>Availability</th>
<th>Certification specifics &amp; Comments</th>
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<td>Fact Sheet</td>
<td>MPC574xP at a glance</td>
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<tr>
<td>Data Sheet</td>
<td>Electrical specifications, pin assignments and package diagrams</td>
<td>Public on NXP homepage</td>
<td>N/A</td>
</tr>
<tr>
<td>Reference Manual</td>
<td>Functional characteristics</td>
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<tr>
<td>User Guide Evaluation Board</td>
<td>Describes how to use the platform for evaluation and HW / SW development of the MPC574xP in 144LQFP &amp; 257BGA packages</td>
<td></td>
<td>ISO 9001 &amp; ISO/TS16949 (automotive quality) ISO 14001 &amp; OHSAS 18001 (environment, health, &amp; safety)</td>
</tr>
<tr>
<td>NXP Quality Certificates</td>
<td>Evidence of international certificates for manufacturing operations, automotive business units and support processes</td>
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<tr>
<td>Safety Manual</td>
<td>Guidelines for the proper use of the MPC574xP Microcontroller in ASIL applications</td>
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<tr>
<td>FMEDA</td>
<td>Systematic analysis technique to obtain subsystem / product level failure rates, failure modes and diagnostic capability</td>
<td>Upon request (NDA needed)</td>
<td>ISO 26262 &amp; IEC 61508</td>
</tr>
<tr>
<td>FMEDA Report</td>
<td>Results of the FMEDA</td>
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<tr>
<td>Safety Plan</td>
<td>Overall approach to functional safety management in accordance with safety requirements</td>
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<tr>
<td>Safety Case</td>
<td>Defines the tailoring of a specific safety standard Work Products for a HW SEooC MCU development in conjunction with the safety plan</td>
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SECURE CONNECTIONS FOR A SMARTER WORLD