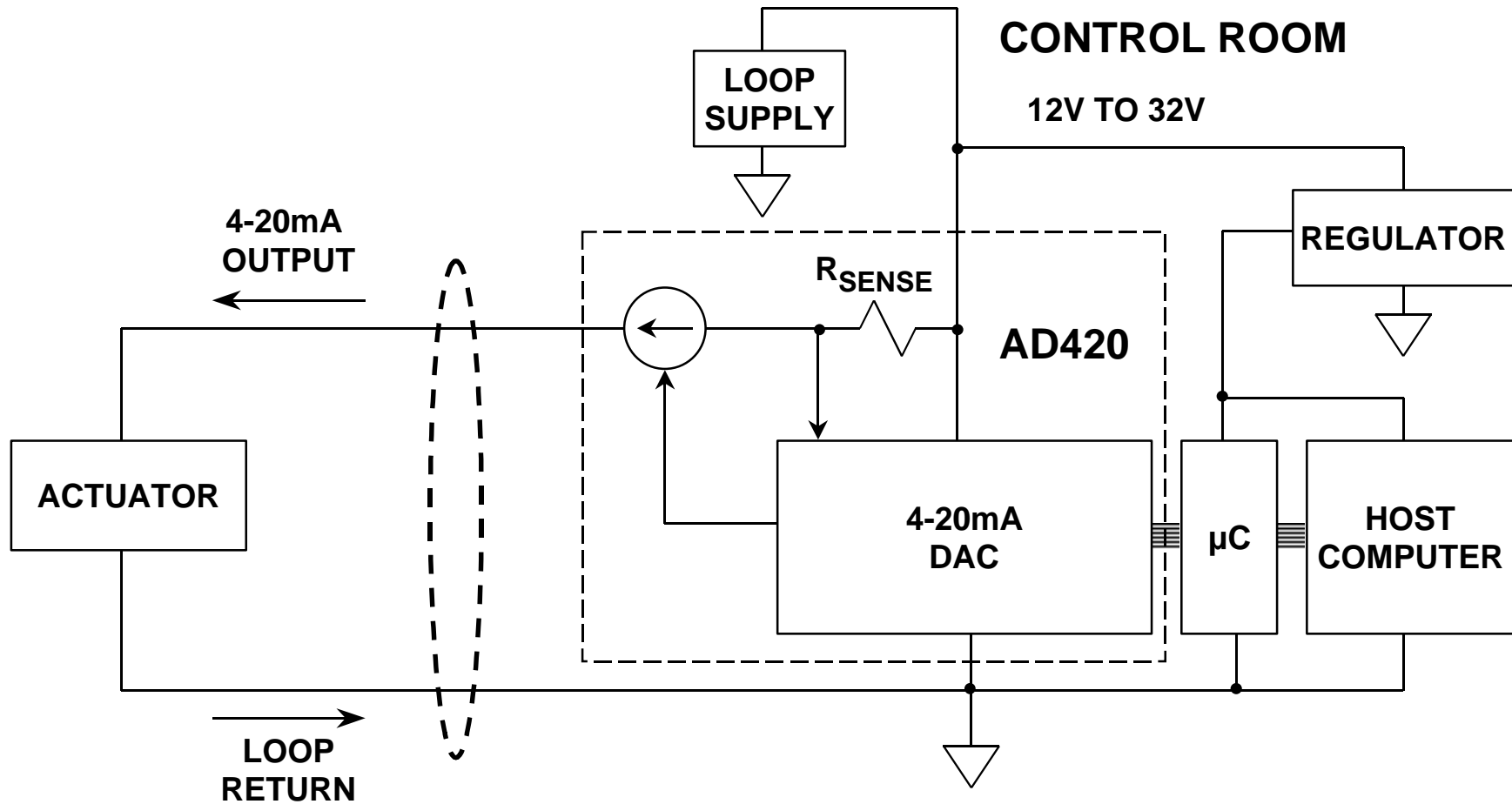


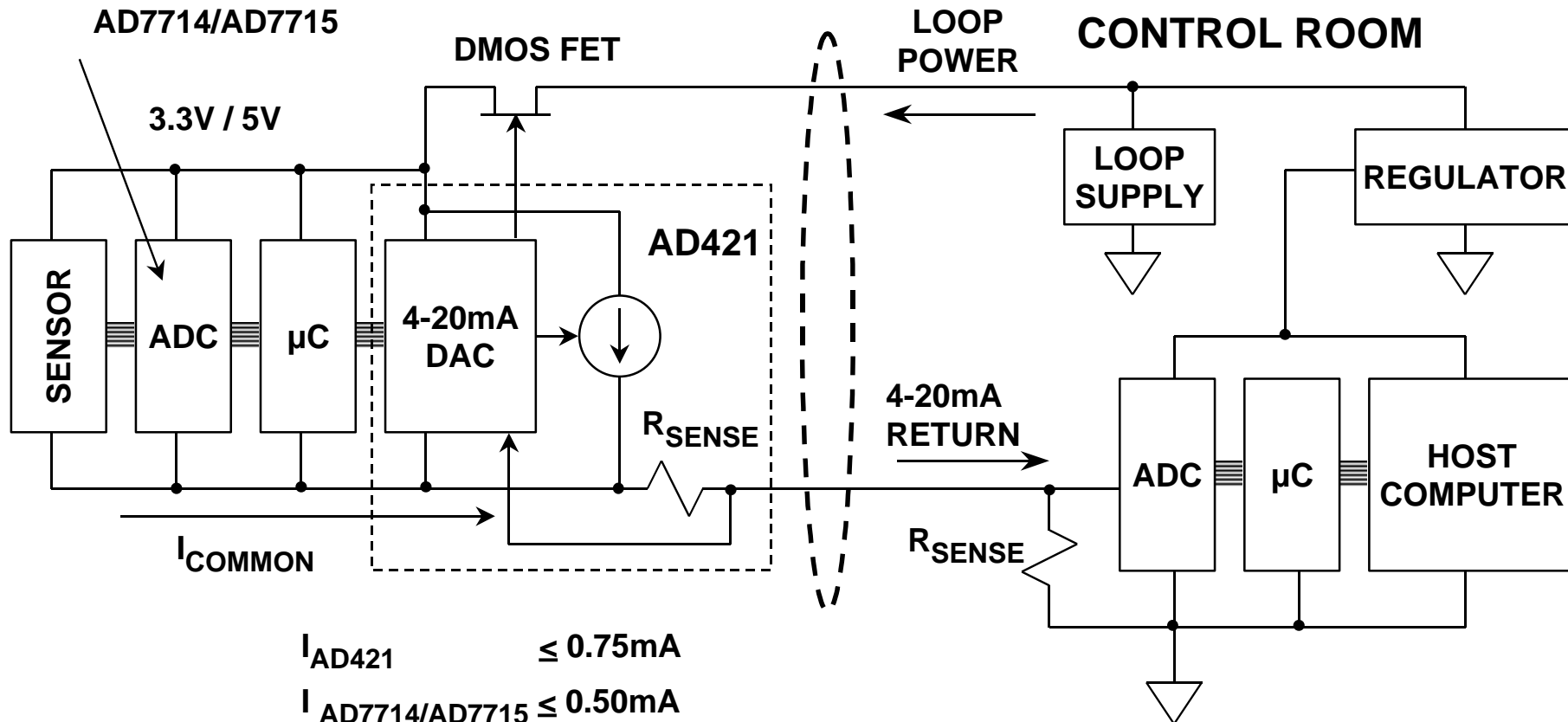
PRACTICAL DESIGN TECHNIQUES FOR SENSOR SIGNAL CONDITIONING

- 1 Introduction**
- 2 Bridge Circuits**
- 3 Amplifiers for Signal Conditioning**
- 4 Strain, Force, Pressure, and Flow Measurements**
- 5 High Impedance Sensors**
- 6 Position and Motion Sensors**
- 7 Temperature Sensors**
- 8 ADCs for Signal Conditioning**
- 9 Smart Sensors**
- 10 Hardware Design Techniques**

CONTROLLING A REMOTE ACTUATOR USING A 4-20mA LOOP



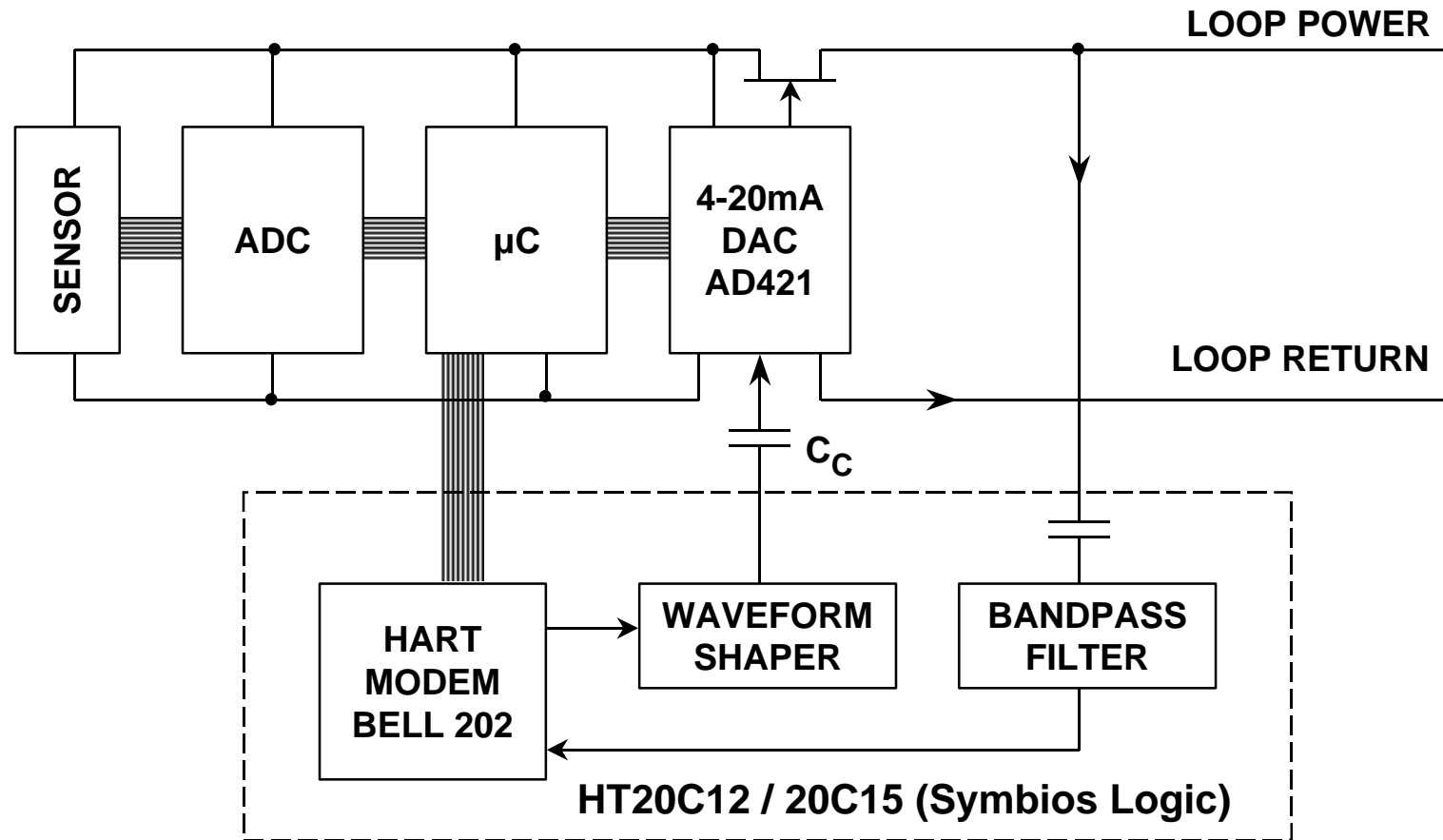
4-20mA LOOP POWERED SMART SENSOR



- $I_{\text{AD421}} \leq 0.75\text{mA}$
- $I_{\text{AD7714/AD7715}} \leq 0.50\text{mA}$
- $I_{\mu\text{C}+\text{SENSOR}} \leq 2.75\text{mA}$
- $I_{\text{COMMON}} \leq 4.00\text{mA}$

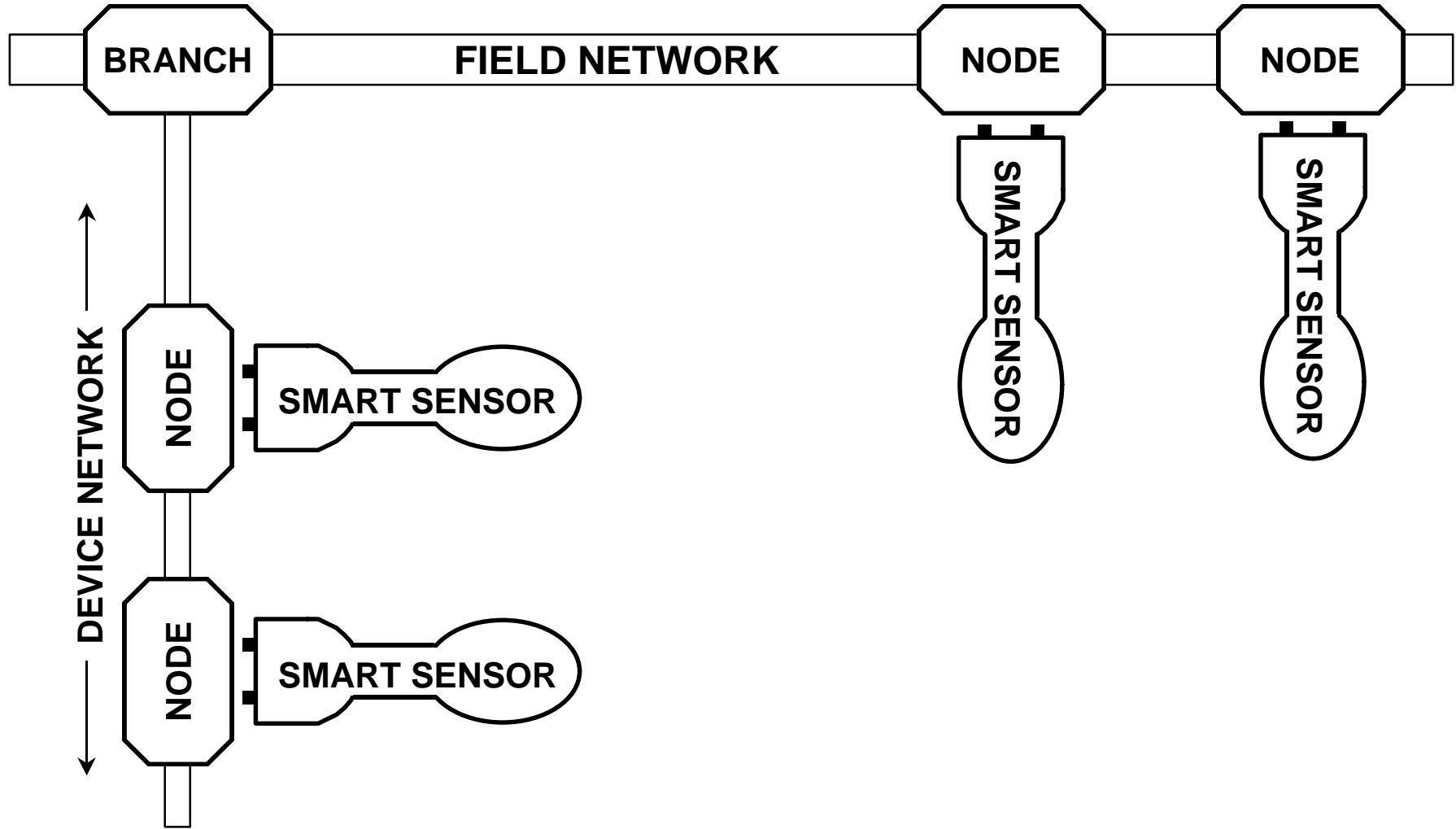
DMOS FET: Supertex DN2535
Siliconix ND2020L or ND2410L

HART INTELLIGENT REMOTE TRANSMITTER USING AD421 LOOP-POWERED 4-20mA DAC



HART DIGITAL SIGNAL: 1200Hz, 2200Hz FREQUENCY SHIFT KEYING (FSK)

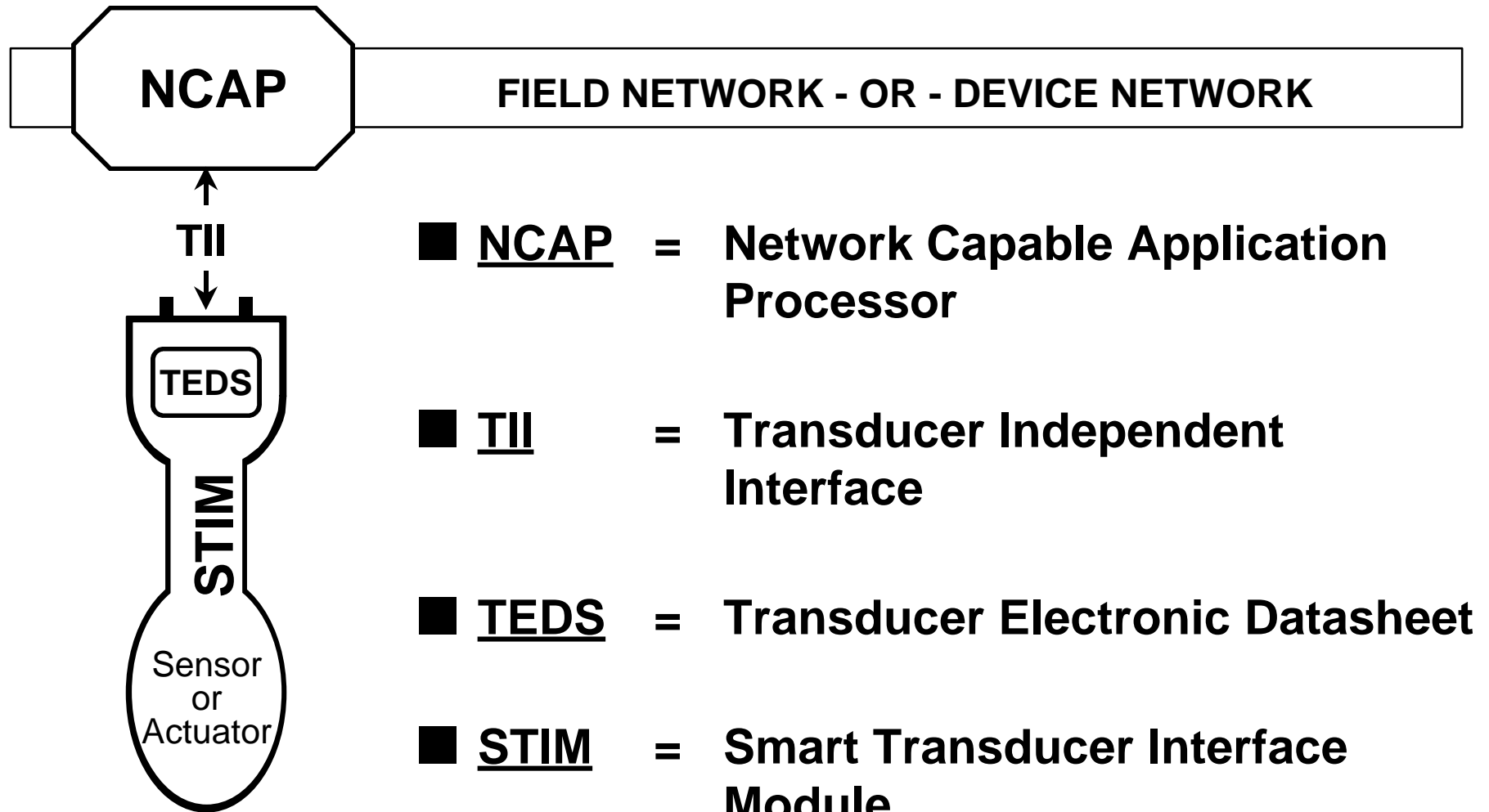
INDUSTRIAL NETWORKING



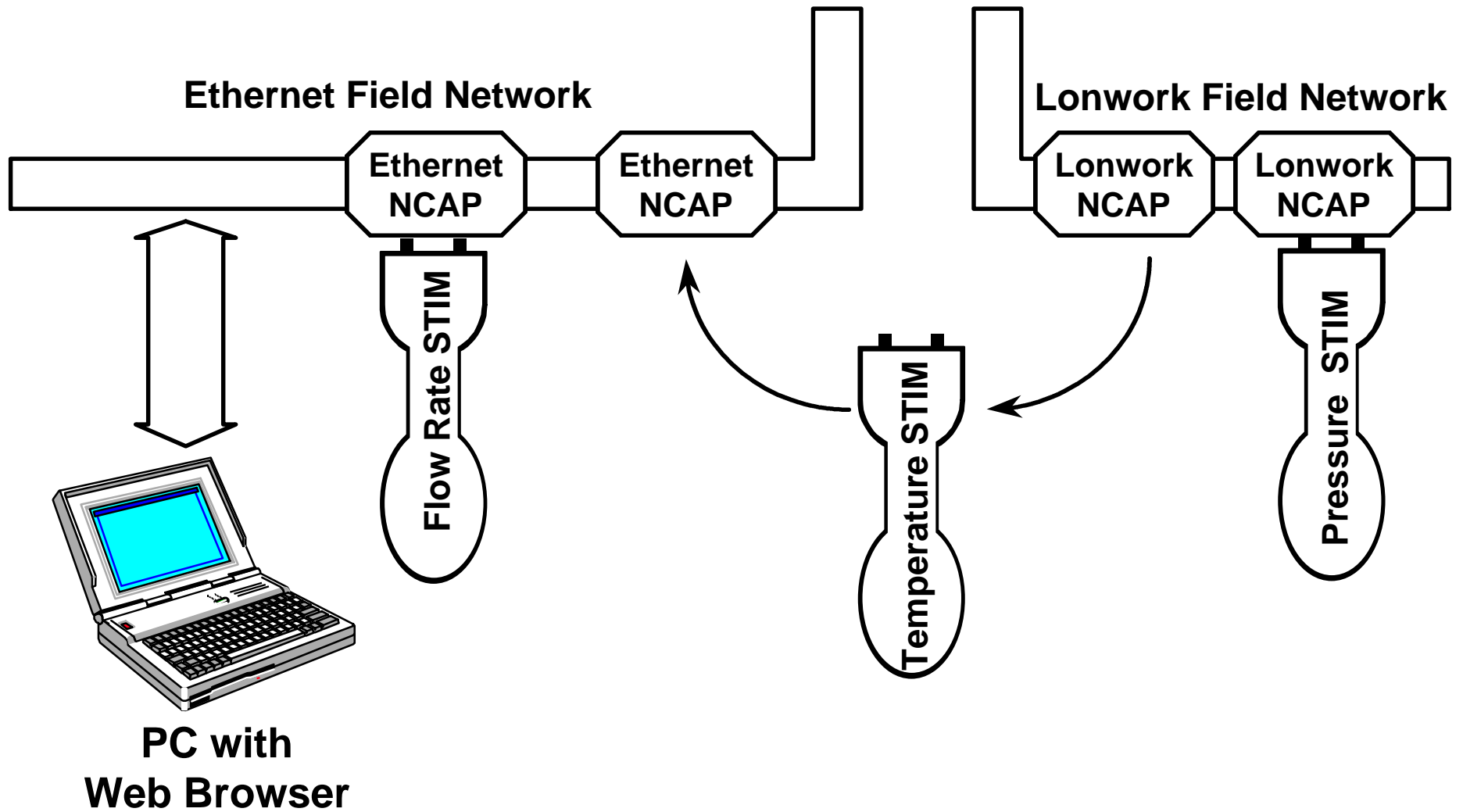
SOME OF THE STANDARDS

- **Ethernet**
- **Foundation Fieldbus**
- **Lonwork**
- **Profibus**
- **Interbus-S**
- **Universal Serial Bus (USB)**
- **CAN-Bus**
- **Device-Net**
- **WorldFIP**
- **P-NET**
- **HART**
- **ASI**

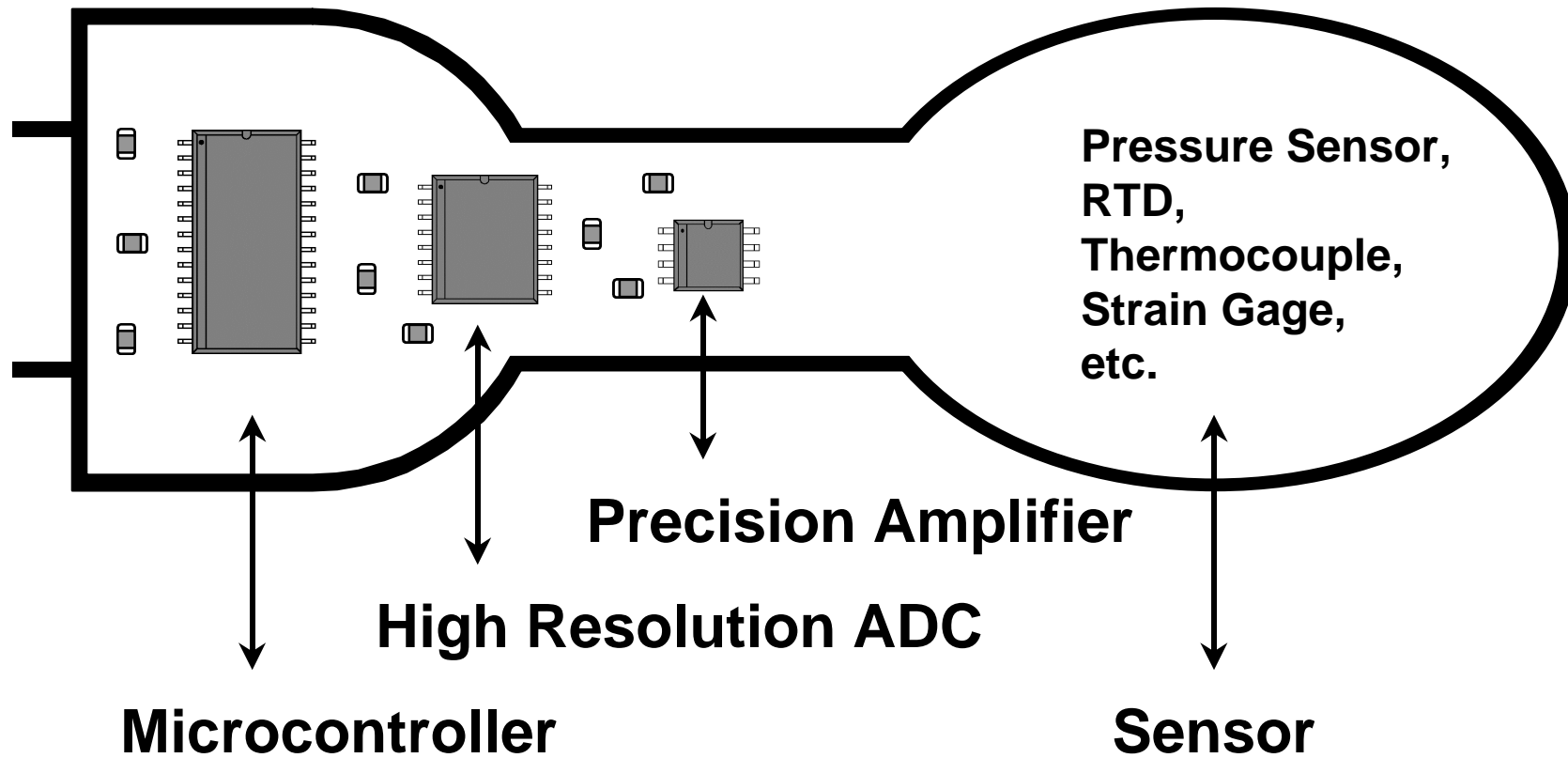
THE IEEE 1451.2 SENSOR INTERFACE STANDARD



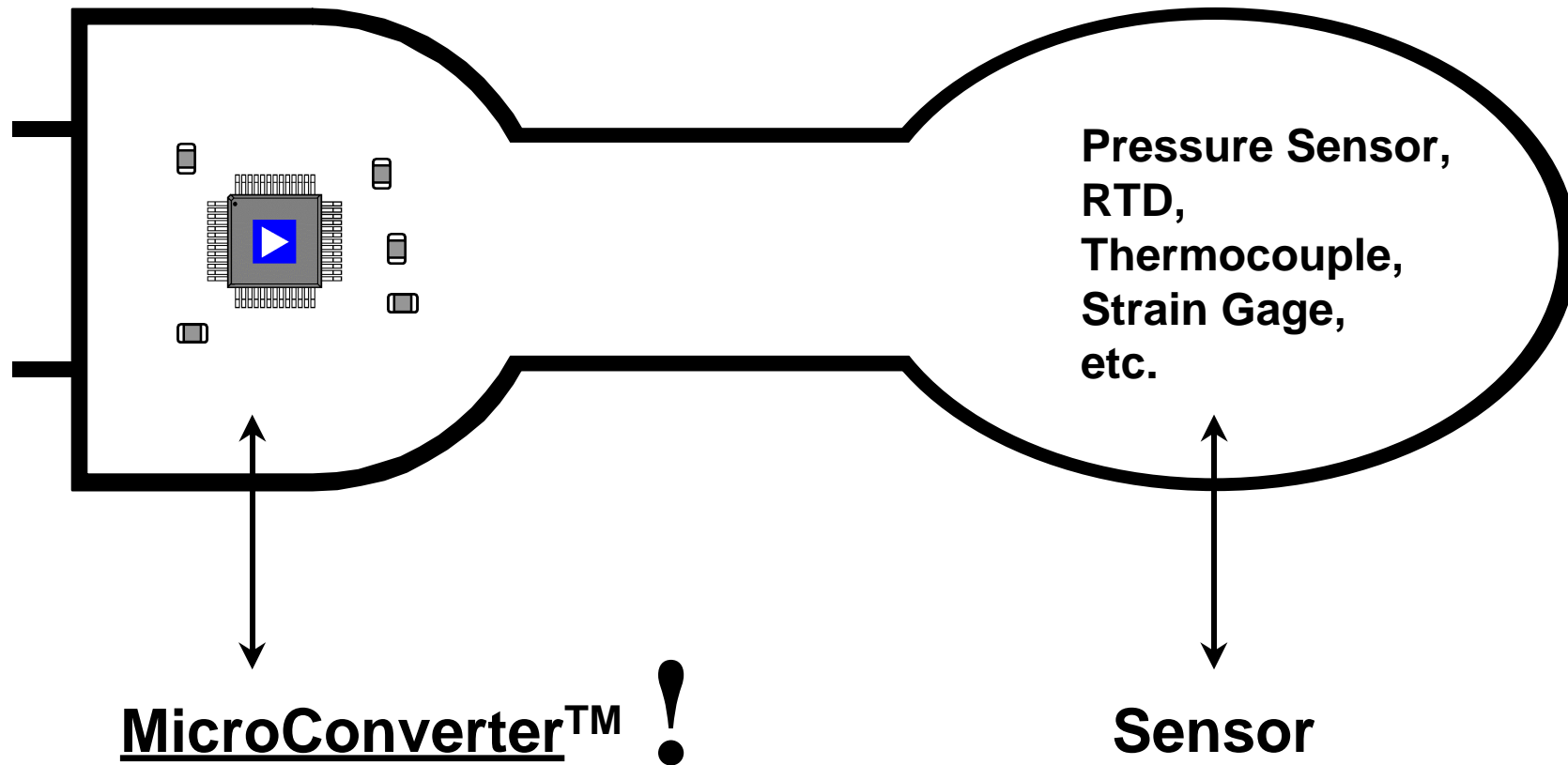
TRUE "PLUG AND PLAY"



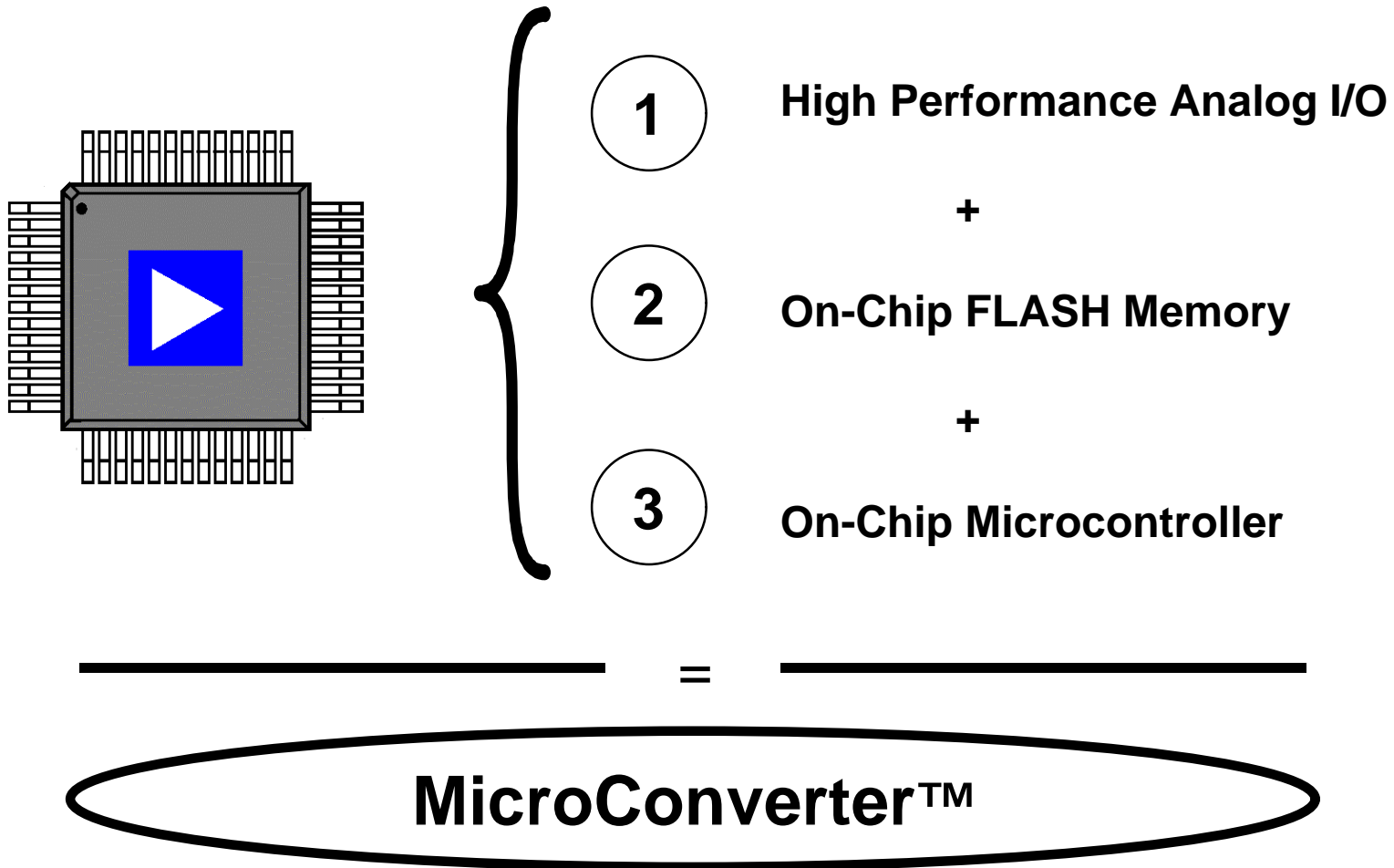
THE SMART SENSOR



THE EVEN SMARTER SENSOR



THE MicroConverter™



ANALOG I/O

1

ADuC816

- Dual $\Sigma\Delta$ ADC
 - ◆ >16 bit
 - ◆ >100dB SNR (p-p)
 - ◆ Differential Inputs
 - ◆ Prog. Gain Amp
 - ◆ Self-Calibration

- 12bit V-Out DAC
 - ◆ < 1/2 LSB DNL

- Voltage Reference

- Temperature Sensor

ADuC812

- 8 chan SAR ADC
 - ◆ 12 bit, 5 μ s
 - ◆ < 1/2 LSB INL
 - ◆ DMA mode
 - ◆ Self-Calibration

- Dual 12bit V-Out DAC
 - ◆ < 1/2 LSB DNL

- Voltage Reference

- Temperature Sensor

ADuC810

- 8 chan SAR ADC
 - ◆ 10 bit
 - ◆ < 1/2 LSB INL

- 12bit V-Out DAC
 - ◆ < 1/2 LSB DNL

- Voltage Reference

- Temperature Sensor

ON-CHIP FLASH MEMORY

②

ADuC816 ; ADuC812 ; ADuC810

- 8K bytes Nonvolatile FLASH Program Memory
 - ◆ Stores Program and Fixed Lookup Tables
 - ◆ In-Circuit Serial Programmable or External Parallel Programmable
 - ◆ Read-Only to Microprocessor Core

- 640 bytes Nonvolatile FLASH Data Memory
 - ◆ User “Scratch Pad” for Storing Data During Program Execution
 - ◆ Simple Read / Write Access Through SFR Space

- Programming Voltage (V_{PP}) Generated On-Chip

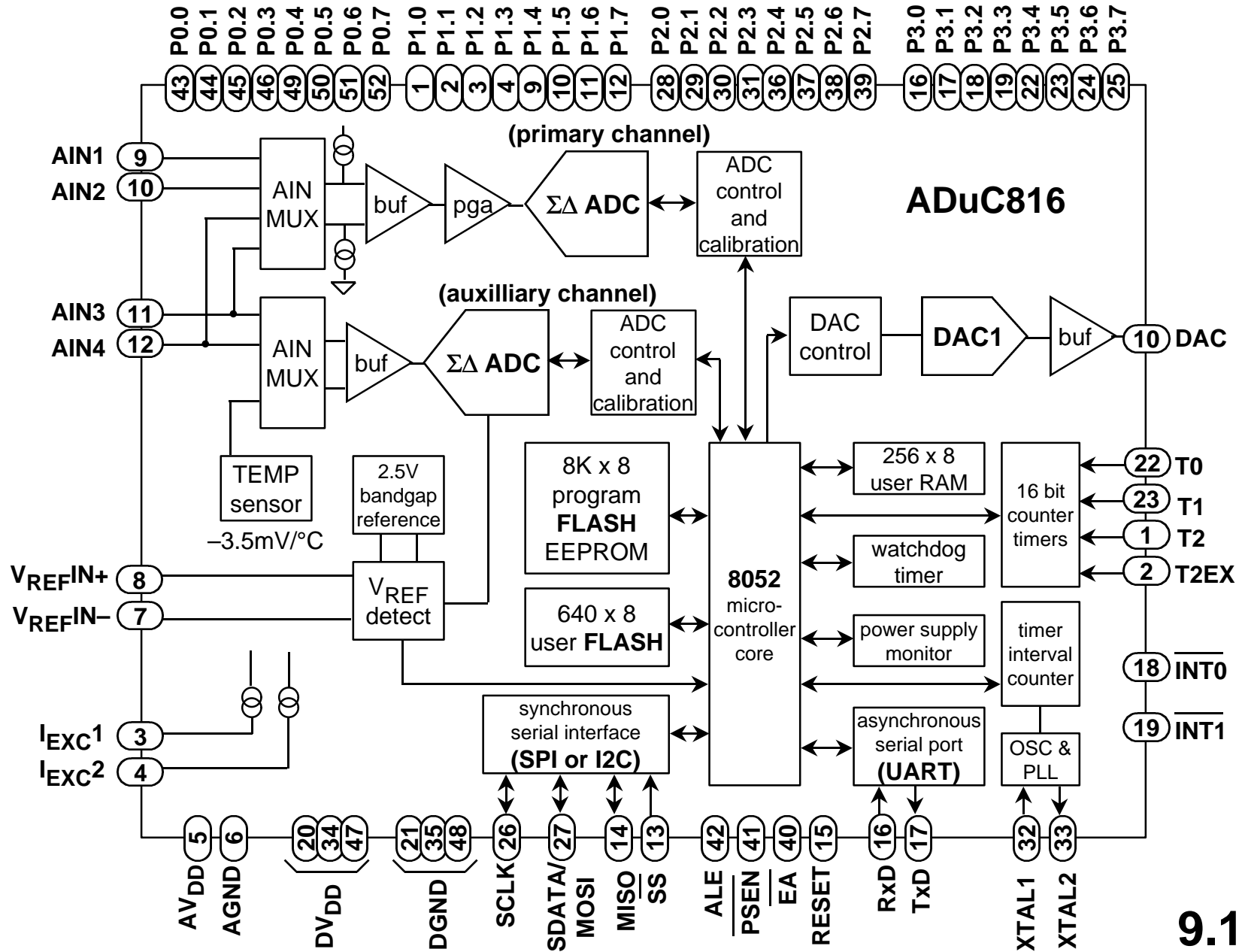
ON-CHIP MICROCONTROLLER (3)

ADuC816 ; ADuC812 ; ADuC810

- Industry Standard 8052 Core
 - ◆ 12 Clock Machine Cycle w/ up to 16MHz Clock
 - ◆ 32 Digital I/O Pins
 - ◆ Three 16bit Counter/Timers
 - ◆ Universal Asynchronous Receiver/Transmitter (UART) Serial Port

- ...Plus Some Useful Extras
 - ◆ SPI or I2C Compatible Serial Interface
 - ◆ WatchDog Timer
 - ◆ Power Supply Monitor
 - ◆ Timer Interval Counter (ADuC816/810)

ADuC816 FUNCTIONAL BLOCK DIAGRAM



ADuC816 - PRIMARY SPECIFICATIONS

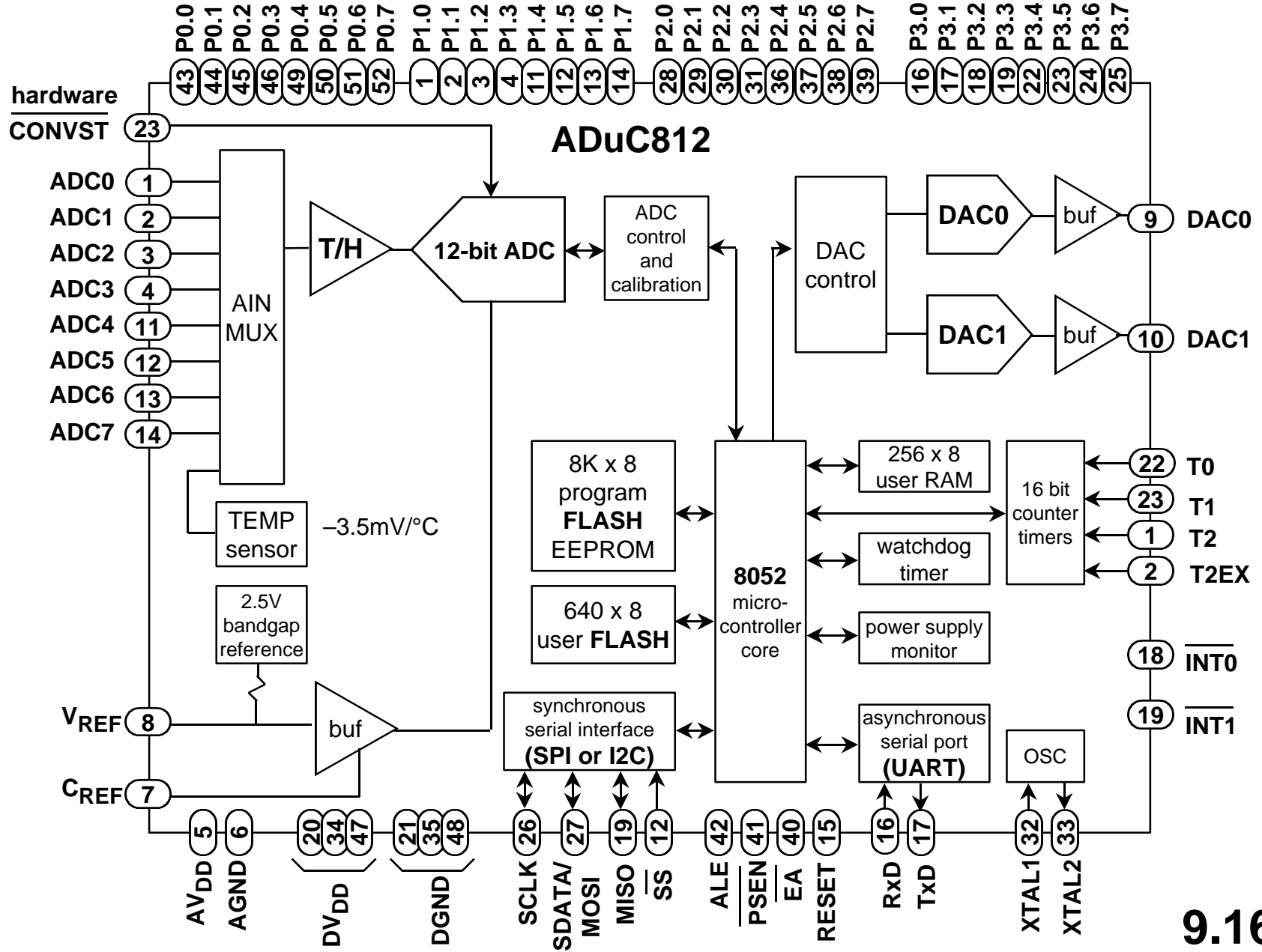
- **ADC** :
 - INL - $\pm 30\text{ppm}$
 - SNR (p-p) - $>102\text{dB}$ (17 Noise Free Bits)
 - Input Range - $\pm 20\text{mV}$ to $\pm 2.56\text{V}$
 - Conv. Rate - 5.4Hz to 105Hz

- **DAC** :
 - DNL - $\pm \frac{1}{2}\text{LSB}$
 - Output Range - 0 to V_{REF} -or- 0 to V_{DD}
 - Settling Time - $<4\mu\text{s}$

- **Power** : Specified for 3V or 5V Operation

	<u>5V</u>	<u>3V</u>
Normal	7mA	3mA
Idle	4.5mA	1.5mA
Powerdown	$<20\mu\text{A}$	$<20\mu\text{A}$

ADuC812 FUNCTIONAL BLOCK DIAGRAM



ADuC812 - PRIMARY SPECIFICATIONS

- ADC :

INL	-	$\pm \frac{1}{2}\text{LSB}$
SNR (p-p)	-	>70dB
Input Range	-	0 to V_{REF}
Conv. Time	-	<5 μs (200kSPS)

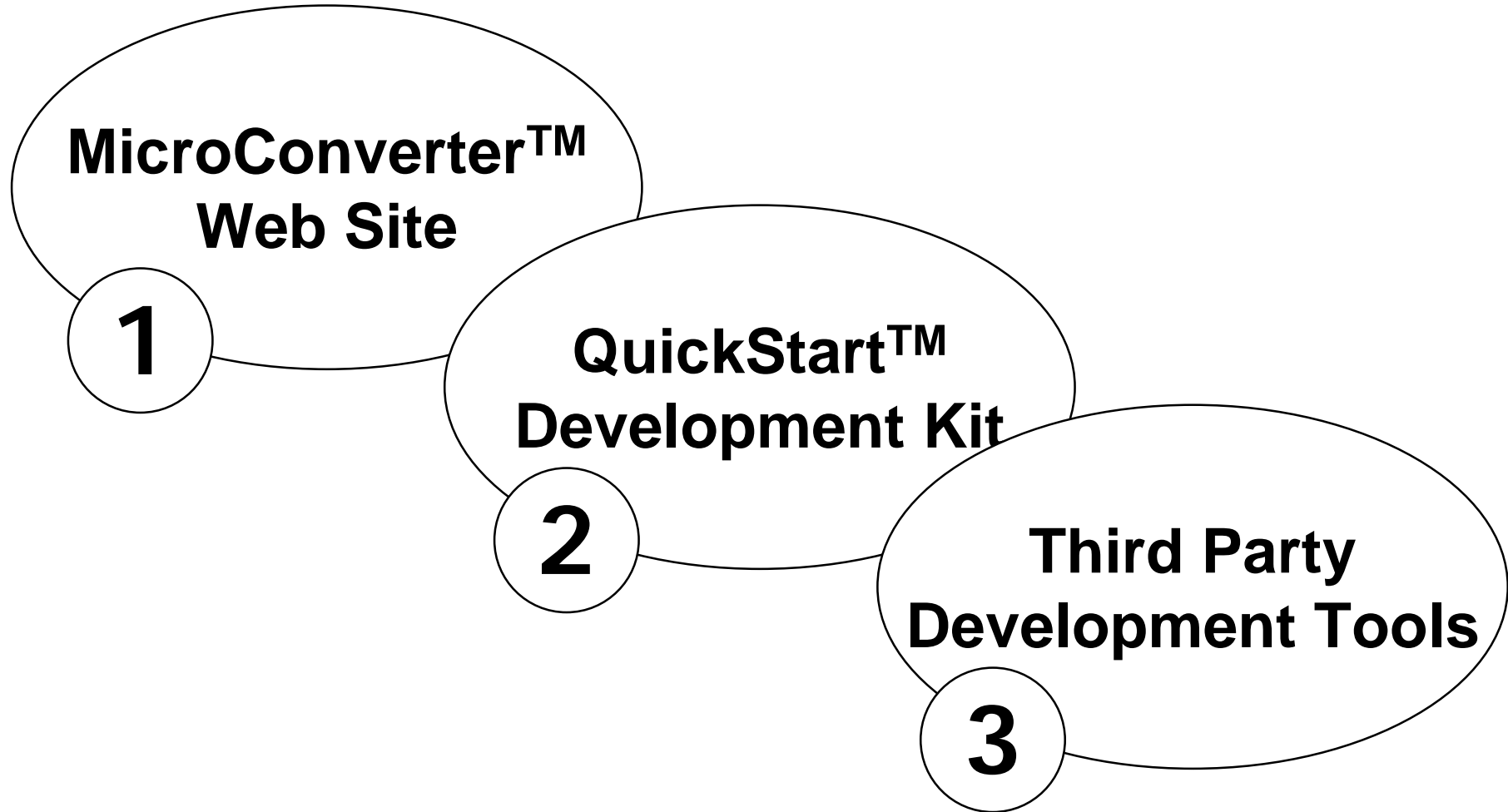
- DAC :

DNL	-	$\pm \frac{1}{2}\text{LSB}$
Output Range	-	0 to V_{REF} -or- 0 to V_{DD}
Settling Time	-	<4 μs

- Power :

	Specified for 3V or 5V Operation	
	<u>5V</u>	<u>3V</u>
Normal	18mA	12mA
Idle	10mA	6mA
Powerdown	<50 μA	<50 μA

MicroConverter™ DESIGN SUPPORT



MicroConverter™ WEB SITE

1

www.analog.com

- Data Sheets
- Application Notes
- 8051 Reference Material
- Free Windows MicroConverter™ Simulator
- Free Keil 'C' Compiler (2K limited version)

MicroConverter™ - QuickStart™ DEVELOPMENT KIT

2

QuickStart™

■ Documentation

- ◆ User's Guide
- ◆ Datasheet
- ◆ Tools Tutorial
- ◆ Quick Reference Guide

■ Evaluation Board

- ◆ RS-232 Serial Comms
- ◆ 32K External SRAM
- ◆ Buffered Analog I/O

■ Regulated Power Supply

■ Serial Port Cable

■ Software

- ◆ Metalink Assembler
- ◆ 'C' Compiler (Limited 2K)
- ◆ Windows Simulator
- ◆ Serial Downloader
- ◆ Windows Debugger
- ◆ Example Code

MicroConverter™ - THIRD PARTY DEVELOPMENT TOOLS

3

The First Two of Many Third Party Tools to Fully Support MicroConverter™ Products:

Power Tools

■ Keil Compiler

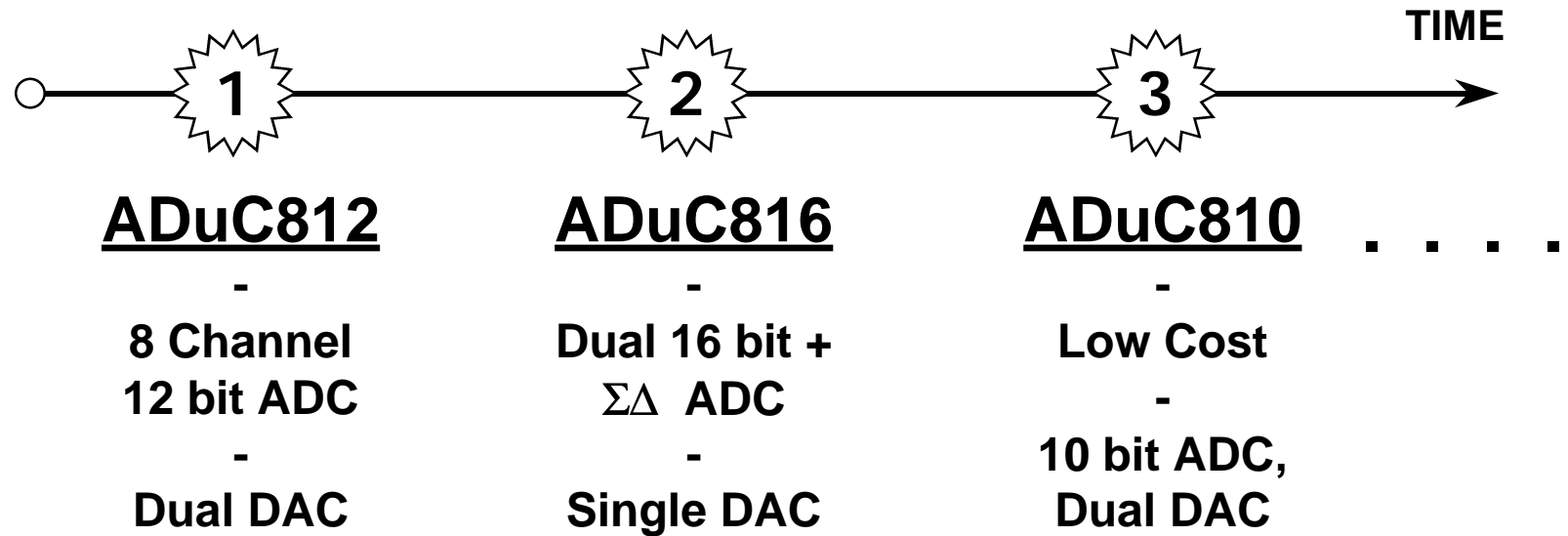
- ◆ A full function *windows based 'C' compiler* environment featuring a simulator for source and assembly level debugging.

■ MetaLink Emulator

- ◆ A high end *in circuit emulation* system offering a complete windows based environment for in-system debug sessions.

All tools will fully integrate with each MicroConverter product

MicroConverter™ PRODUCT ROADMAP



..... Future Products May Include:

- Larger FLASH Memory Capacity (Data and Program)
- Hardware Communications Interface Enhancements (CAN Bus, USB Bus)
- Increased Microcontroller Horsepower