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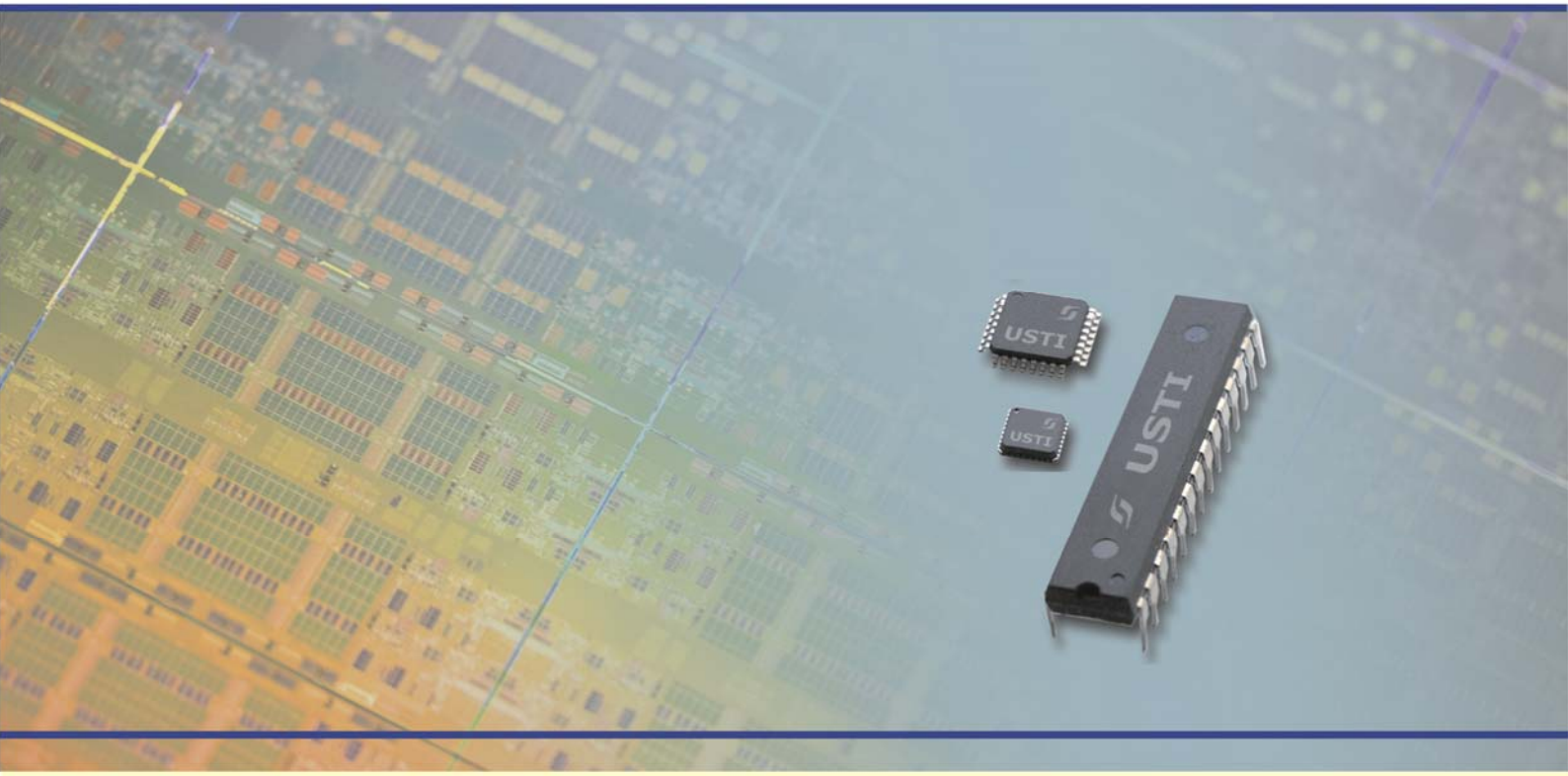

UFDC-1 **UFDC-1M-16** **USTI** **USTI-EXT** **EVAL UFDC-1/1M-16**

Product Overview and Price List

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2012

Technology Assistance BCNA 2010, S. L. (TAB) - the company

Since its founding in 2010, TAB has continued to design and manufacture novel integrated circuits and sensor systems solutions based on precision measurements of frequency-time parameters of signals. The aim is to provide the most innovative solutions with a high degree of flexibility and openness with added value to customers by means of new measuring and sensing technologies, based on novel, advanced, patented methods of measurements.

The key to TAB‘s products is ultra-precise measurement technology in terms of universal frequency-to-digital converter (UFDC). In this field, TAB's experts developed its core technology over dozens years, that meet an extremely high degree of precision, broad frequency range, scalable resolution and non redundant conversion time. The universal applicability of frequency-time measurements opens a wide market for such integrated circuits.

Technologies

TAB‘s focus is on measuring tasks that require a broad frequency range, constant, selectable and low relative error of measurement and the best tradeoff between accuracy and speed. While a standard counter solutions are based on classical methods of measurements TAB‘s products are based on four patented, advanced methods of frequency-time measurements.

The use of pure digital CMOS circuit design also makes it easy to adapt the UFDC to different custom ICs, ASIC designs as IP. The TAB‘s strong core competence is the development of customized ICs, which are tailored to the various specific measurement requirements of customers. TAB's products applications are numerous: from various physical and chemical digital sensors and sensor systems (including smart and intelligent) to sensor instrumentation and data acquisition systems for automotive industry, avionics, military and OEM applications.

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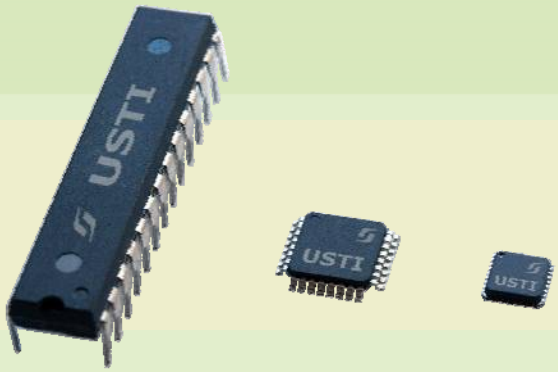


Product Overview

Universal Frequency-to-Digital Converter (UFDC-1)

General Description

The Universal Frequency-to-Digital Converter (UFDC-1) is a fully digital CMOS integrated circuit based on novel patented methods for frequency, period, its ratio, duty-cycle and phase-shift measurements. By using this IC it is possible to build a wide variety of digital, smart sensors and intelligent sensor systems. The device represents a high-resolution conversion for data acquisition systems designed to support all range of frequency-time domain and digital sensor applications. It offers high performance with flexibility and requires minimum possible number of external components.

The UFDC-1 can be easy included into digital environment, controlled by an external microcontroller (slave mode) or work independently as a separate measuring unit without an external control (master mode). The function selection can be configured in both software and hardware.

The IC converts frequency-time domain signals into digital domain and provides interface to microcontroller, DAQ or sensor system to read these digital results. resolution and programmable accuracy during the non-redundant conversion time.

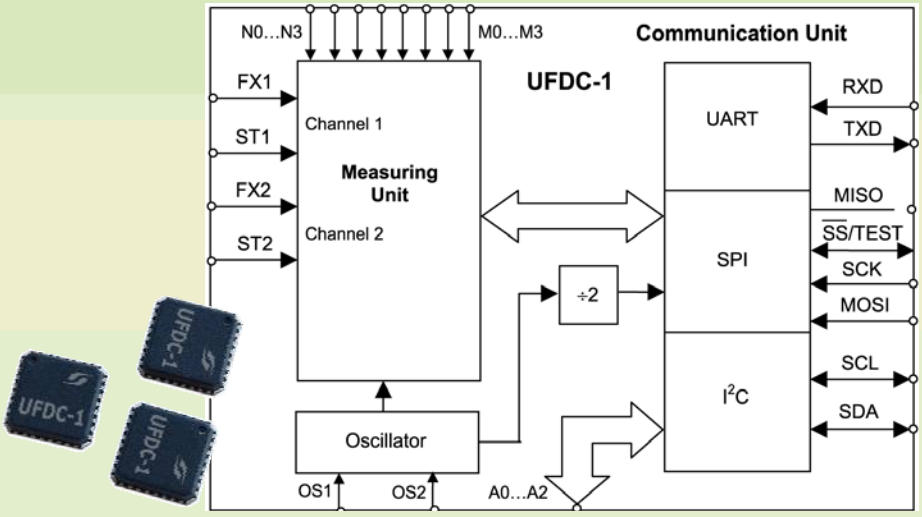
The UFDC-1 has 16 measuring and one generating modes. The measuring mode can be hardware-selected by using four selection external pins M0-M2 and the relative error by using four selection pins N0-N2 (RS232 master communication mode). The mode and accuracy can be also selected by using any of three possible interfaces (slave communication mode). A communication interface type (RS232, SPI or I2C) can be automatically selected according to the circuit connection.

The UFDC-1 can also work with any voltage and current output sensors. It this case, any voltage–to-frequency converter (VFC) can be used. The accuracy of such system will be determined by sensor accuracy as well as by VFC accuracy.

Features

- 16 measuring modes and one generator mode
- 2 channels for frequency and period measurements
- Provides frequency (time)-to-digital conversion for many types of sensors and transducers
- Frequency range from 0.05 Hz up to 7.5 MHz without prescaling and 120 MHz with prescaling;
- Programmable accuracy (relative error) for frequency (period) conversion from 1 % to 0.001 %
- Relative quantization error is constant in all specified frequency range
- Non-redundant conversion time
- Scalable resolution
- Internal reference clock 500 kHz @ 16 MHz quartz oscillator
- Quartz-accurate automated calibration
- 3-wire serial interface (SPI compatible)
- 2-wire interface (I^2C compatible)
- RS232/485 serial interface
- Master and slave communication modes
- Frequency generator mode 8 MHz with quartz crystal stability

Block Diagram



Measuring Modes

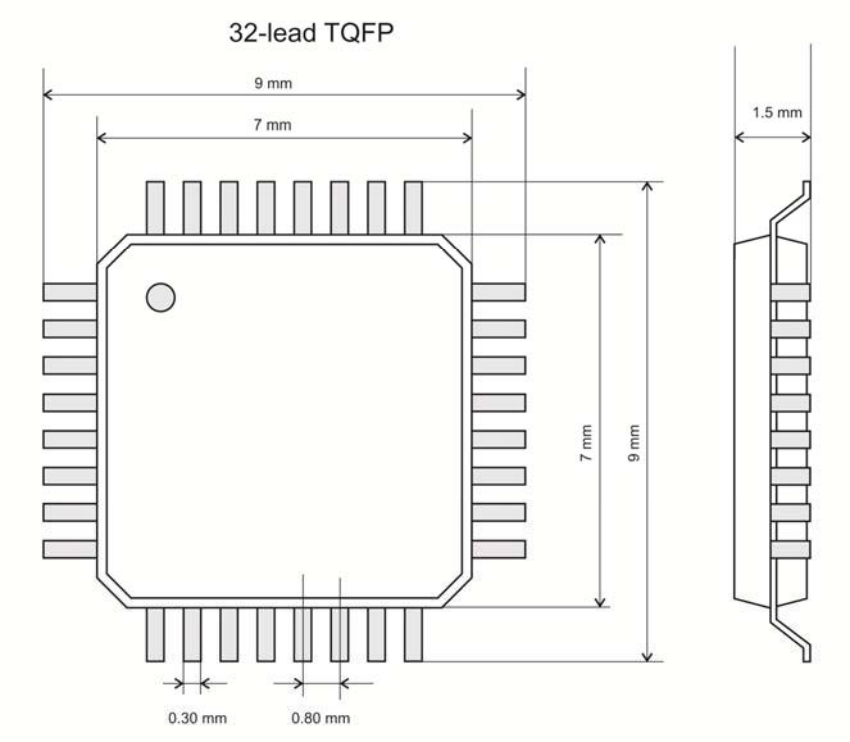
- Frequency, f_{x1} 0.05 Hz – 7.5 MHz directly and up to 120 MHz with prescaling
- Period, T_{x1} 150 ns – 20 s
- Phase shift, φ_x 0 - 360^0 at f_{xmax} = 500 kHz at 50 % duty-cycle
- Time interval between start – and stop-pulse, τ_x
  2 μs – 250 s
- Duty-cycle, D.C. 0 – 1 at $f_{xmax} \leq 500$ kHz
- Duty-off factor, Q 10^{-8} – $8 \cdot 10^6$ at $f_{xmax} \leq 500$ kHz
- Frequency difference, $f_{x1} - f_{x2}$ with sign recognition, 0 – 7.5 MHz
- Period difference, $T_{x1} - T_{x2}$ with sign recognition, 0 – 20 s
- Frequency ratio, f_{x1}/f_{x2} 7×10^{-9} – 1.4×10^8
- Period ratio, T_{x1}/T_{x2} 7.5×10^{-9} – 1.33×10^8
- Rotation speed, $n_x = (f_x \times 60)/Z$, where Z is the number of encoder teeth
- Pulse width, t_p 2 μs – 250 s
- Space interval, t_s 2 μs – 250 s
- Pulse number (events) counting, N_x 0 – 4×10^9

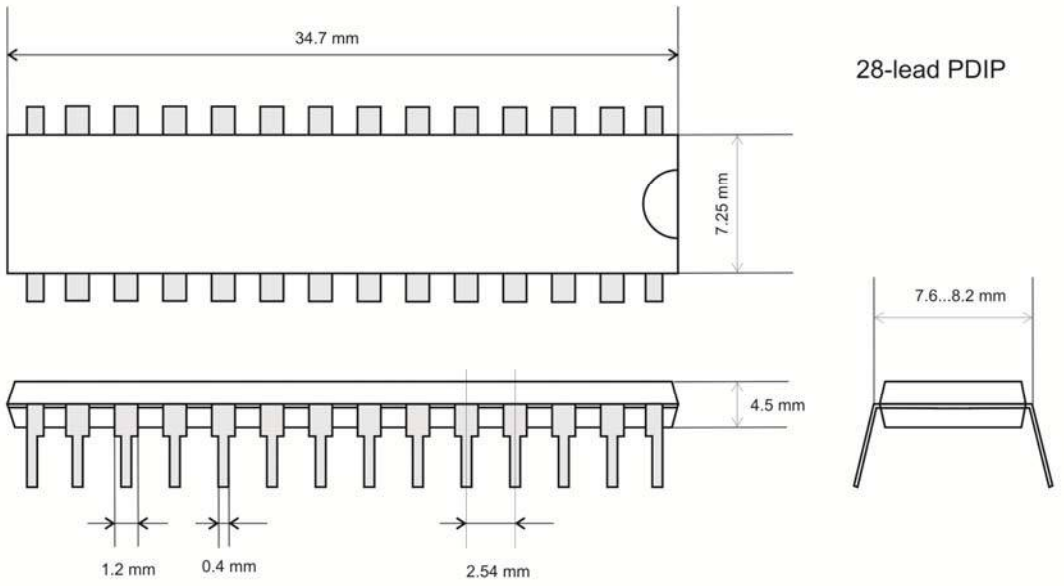
General

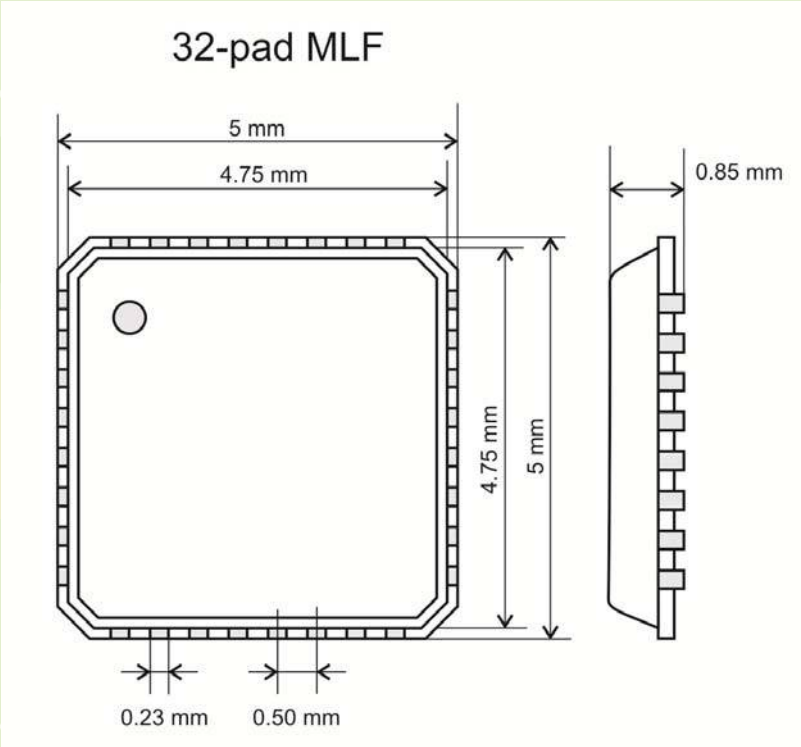
- Single power supply, V: 4.5 – 5.5
- External reference frequency, MHz: 16
- Internal reference frequency, kHz: 500
- Conversion time, s: 0.0002 to 0.2
- Supply current (at 16 MHz, 4.5 V, 25ºC), mA: 17.5
- Operating temperature range -40ºC to +85ºC
- Storage temperature range -65°C to +150°C
- Packages: 28-lead PDIP; 32-lead TQFP, 32-pad MLF

The UFDC-1 is available as IP for the use in various microelectronic design. This device can be supplied also in wafer form.

Packages




28-lead PDIP
34.7 mm
7.25 mm
7.6...8.2 mm
4.5 mm
1.2 mm
0.4 mm
2.54 mm


32-pad MLF
5 mm
4.75 mm
0.85 mm
4.75 mm
5 mm
0.23 mm
0.50 mm

Communication Modes

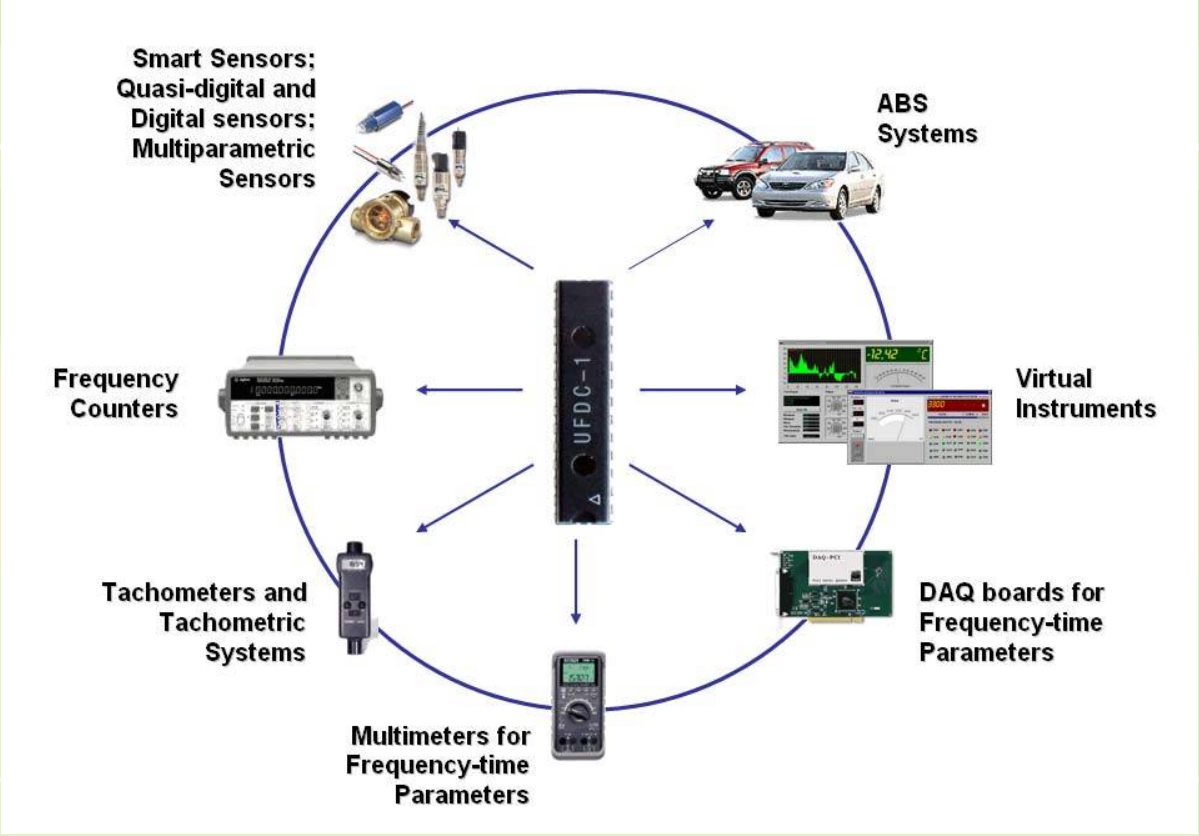
The UFDC-1 can work as an independent measuring unit (master mode), controlled by any external microcontroller (or embedded into a sensor), DAQ board or PC (slave mode). In the master mode, the conversion accuracy and measurement mode should be selected by external switches. In this mode the UFDC-1 works only through the RS232 interface in a unidirectional mode. In the slave mode (with an external microcontroller), all measuring modes and programmed accuracy can be set up by a data bus or through communication I/O ports of master microcontroller. This allows us use the UFDC-1 as a simple peripheral circuit for a microcontroller.

A bidirectional data exchange is possible with any of three interfaces RS232, SPI or I2C. The UFDC-1 works as a standard element in different systems with I^2C bus architecture, or can be controlled through the RS232 or SPI interfaces. The choice of interface can be performed automatically depend on the circuit connections.

Applications

The UFDC-1 has many applications. Some typical applications are following:

- Any physical, chemical or biosensor systems
- Any frequency, period, duty-cycle, time interval, phase-shift, pulse number output sensors in order to produce a digital output
- Digital sensors design
- Smart (self-adaptive) sensors due to programmable accuracy and non-redundant conversion time - adaptive possibilities of UFDC-1 automatically choice the conversion time depending on the given error of measurement and opposite
- Multifunctional and multiparameters sensors for simultaneous detection various parameters proportional to frequency and duty-cycle carrying the information provided by sensing elements.
- Data acquisition (DAQ) boars and systems for frequency-time parameters
- Virtual instruments
- Desktop multifunctional frequency counters
- Tachometers and tachometric systems
- Handheld multimeters for frequency-time parameters of electric signals
- High-end, mid- and low-range ABS
- High accuracy programmable frequency-time parameters – to – digital converters for different measuring and communication applications



Universal Frequency-to-Digital Converter (UFDC-1M-16)

General Description

The UFDC-1M-16 is a high speed version of UFDC-1 IC with 16 MHz internal and external reference frequencies and conversion time from 0.00000625 ... 0.00625 s for 1 % to 0.001 % constant relative error respectively. The UFDC-1M-16 has the same functionality, pin out, housing, set of commands, measuring and communication modes as the UFDC-1 IC.

Features

- 16 measuring modes and one generator mode
- 2 channels for frequency and period measurements
- Provides frequency (time)-to-digital conversion for many types of sensors and transducers
- Frequency range from 1 Hz up to 7.5 MHz without prescaling and 120 MHz with prescaling;
- Programmable accuracy (relative error) for frequency (period) conversion from 1 % to 0.001%
- Relative quantization error is constant in all specified frequency range
- Non-redundant conversion time
- Scalable resolution
- Internal reference clock 16 MHz @ 16 MHz quartz oscillator
- Quartz-accurate automated calibration
- 3-wire serial interface (SPI compatible)
- 2-wire interface (I2C compatible)

RS232/485 serial interface
Master and slave communication modes
Frequency generator mode 8 MHz with quartz crystal stability

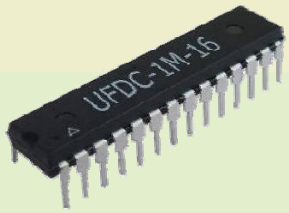
Measuring Modes

- Frequency, f_{x1} 1 Hz – 7.5 MHz directly and up to 120 MHz with prescaling
- Period, T_{x1} 150 ns – 20 s
- Phase shift, φ_x 0 - 360^0 at f_{xmax} = 500 kHz at 50 % duty-cycle
- Time interval between start – and stop-pulse, τ_x 2 μs – 250 s
- Duty-cycle, D.C. 0 – 1 at $f_{xmax} \leq 500$ kHz
- Duty-off factor, Q 10^{-8} – $8 \cdot 10^6$ at $f_{xmax} \leq 500$ kHz
- Frequency difference, $f_{x1} - f_{x2}$ with sign recognition, 0 – 7.5 MHz
- Period difference, $T_{x1} - T_{x2}$ with sign recognition, 0 – 20 s
- Frequency ratio, f_{x1}/f_{x2} 7×10^{-9} – 1.4×10^8
- Period ratio, T_{x1}/T_{x2} 7.5×10^{-9} – 1.33×10^8
- Rotation speed, $n_x = (f_x \cdot 60)/Z$, where Z is the number of encoder teeth
- Pulse width, t_p 2 μs – 250 s
- Space interval, t_s 2 μs – 250 s
- Pulse number (events) counting, N_x 0 – $4 \cdot 10^9$

The UFDC-1M-16 is available as IP for the use in various microelectronic design. This device can be supplied also in wafer form.

Main Differences Between UFDC-1M-16 and UFDC-1 ICs

	UFDC-1	UFDC-1M-16
Internal reference frequency, MHz	0.5	16
Frequency measuring range	0.05 Hz ... 7.5 (120) MHz	1 Hz ... 7.5 (120) MHz
Conversion time, s	0.0002 ... 0.2	0.00000625 ...0.00625



Evaluation Board EVAL-UFDC-1 / 1M-16

General Description

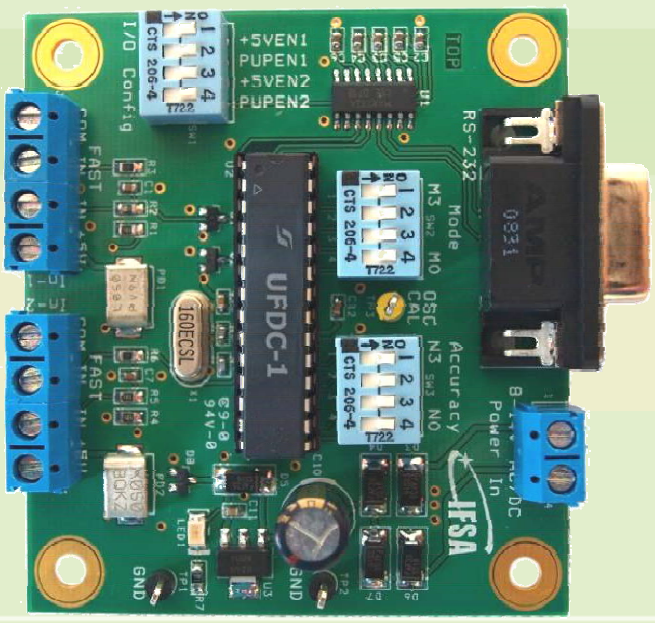
The EVAL-UFDC-1/UFDC-1M-16 is a simple full featured evaluation and development board (universal counter module) that allows users to quickly evaluate the performance of the Universal Frequency-to-Digital Converters UFDC-1 and UFDC-1M-16 without the need for external components and design various DAQ systems on its basis. This 2-channel Evaluation Board lets use such ICs in 16 frequency-time parameters measuring modes, one generation (for a calibration purpose) mode and build various digital sensors and sensor systems including smart, self-adaptation and self-identification sensor systems.

All existing frequency, period, duty-cycle, time interval, pulse-width modulated, pulse number and phase-shift output sensors and transducers can be directly interfaced to this evaluation board. The user can connect TTL-compatible sensors' outputs to the Evaluation Board, measure any output frequency-time parameters, and test out the sensor systems functions.

Using the accompanying software, the EVAL-UFDC-1/UFDC-1M-16 evaluation board can be interfaced to any personal computer running Windows XP/Vista/Windows 7, via one of the serial computer's com port RS232 or USB port (with an additional USB to Serial (9-pin) DB9 RS232 adapter cable, for example, EMINENT USB to Serial Converter).

Four holes are provided for mechanical attachment of the Evaluation Board to users' applications.

The RS232 interfacing chip MAX232CSE offers a serial communication between the UFDC-1/UFDC-1M-16 and, for instance, a personal computer or external (master) microcontroller. A 16 MHz crystal completes the on-chip oscillator of the UFDC-1/1M-16. The board is working from 8 to 14 V AC/DC external power supply. The LM7805CT voltage regulator provides the +5 V, DC supply voltages for the integrated circuit.



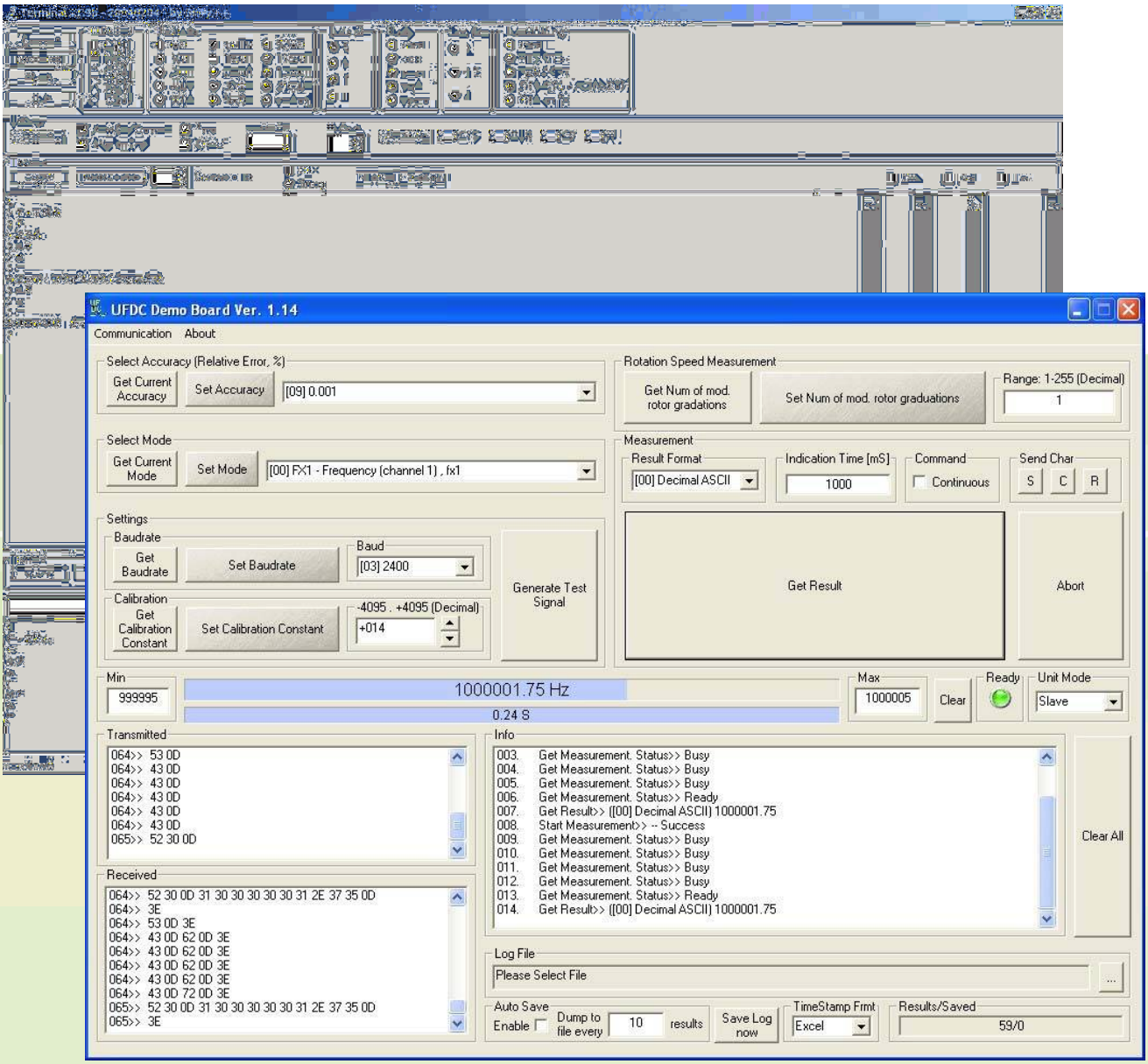
Software

The software allows the EVAL-UFDC-1/UFDC-1M-16 Evaluation and Development board's functions to be controlled from a PC via an easy-to-use interface operating under Windows XP/Vista/Windows 7. There are many ways to display evaluated results, such as the terminal programs for Windows, LabView and special software supplied with the Evaluation Board. Any terminal program for Windows, for example, Terminal V1.9b, can easily display the measurement results and accept the programming commands for measuring modes, accuracy selections, etc. via the serial port of the PC. The original UFDC EVAL Software V1.14 does not need any installation.

The software also lets to calibrate the converters and put a calibration constant into the converter's memory.

Applications

- Digital sensor systems
- Smart and intelligent sensor systems
- Data Acquisition systems for frequency-time parameters of electric signals
- Frequency counters
- Tachometers and tachometric systems
- Various virtual instruments
- Educational process in sensors and measurements
- Remote laboratories and distance education



Universal Sensors and Transducers Interface (USTI)

General Description

The awards-winning Universal Sensors and Transducers Interface (USTI) is the next generation of TAB's ICs. Higher accuracy and wide functionalities make it ideal for various sensor and measuring applications. With special function blocks like resistance-, capacitance and resistive bridge-to time-to-digital converters it is perfectly suited for different sensors and transducers.

The USTI is a fully digital CMOS integrated circuit of universal, 2-channel, high precision, multifunctional converter based on novel, advanced methods for frequency, period, its ratio, duty-cycle and phase-shift measurements. It is perfectly suited to any applications where frequency-time parameters but also sensors output signal, have to be measured with highest resolution and programmable accuracy during the non-redundant conversion time.

The USTI covers a wide range of frequencies and accuracies for modern frequency-time domain sensors. In addition, the USTI provides interfacing for resistive (including platinum, cuprum resistors and thermistors), capacitive sensing elements and resistive bridges.

By using this IC it is possible to build a wide variety of digital, smart sensors and intelligent sensor systems. The device represents a high-resolution conversion and designed to support all range of frequency-time domain and digital sensor applications. It offers high performances with flexibility and requires minimum possible number of external components.

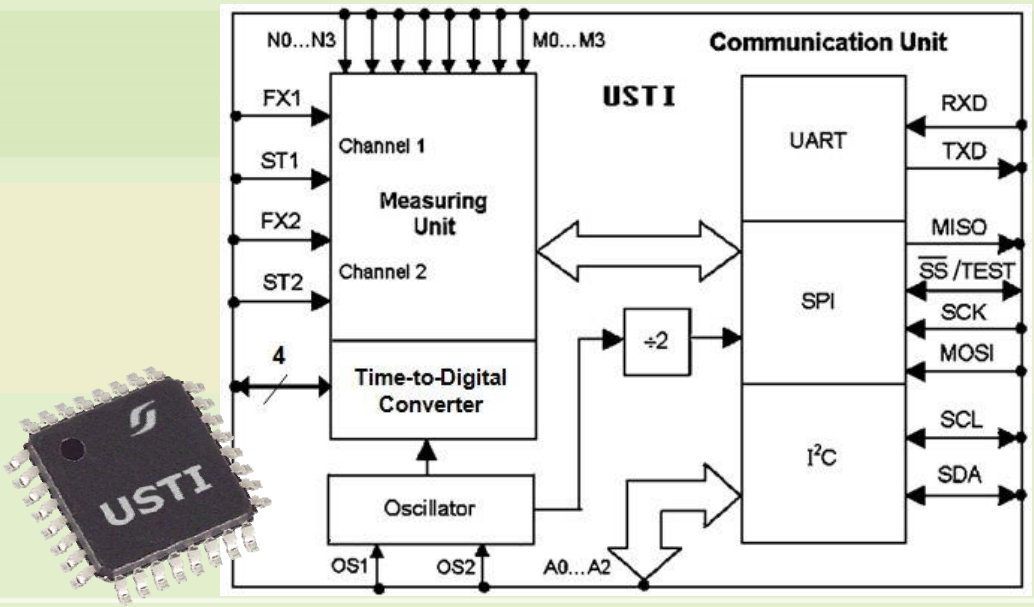
The USTI can be easy included into digital environment, controlled by an external microcontroller (slave mode) or work independently as a separate measuring unit without an external control (master mode). The function selection can be configured in both software and hardware.

The IC converts frequency-time domain signals, resistance and capacitance of sensing elements and resistance of sensor bridges into digital and provides digital, bus interface to microcontroller, DAQ or sensor system to read these digital results. Sensing elements can be directly connected to the USTI without the need for extra electronics. Only a single reference element, of the same kind as the sensor, is required.

General

- Single power supply, V: 4.5 – 5.5
- External reference frequency, MHz: 20
- Internal reference frequency, kHz: 625
- Conversion time, s: 0.00016 to 0.32
- Supply current (at 20 MHz, 4.5 V, 25ºC), mA: < 9.5
- Operating temperature range -40 ºC to +85 ºC
- Storage temperature range -65 °C to +150 °C

Block Diagram



Features

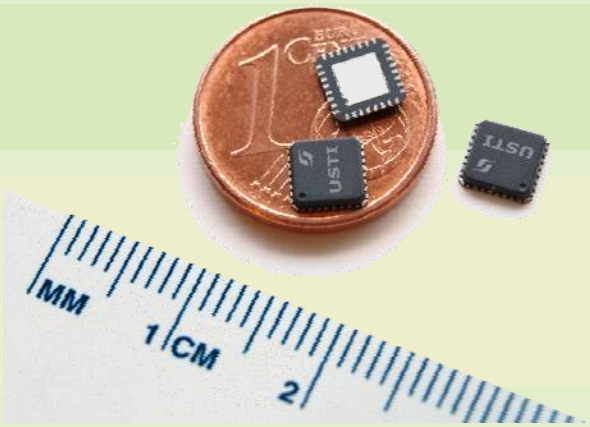
- 29 measuring modes and one generator mode
- 2 channels for all frequency-time parameters
- Provides frequency (time)-to-digital conversion for many types of sensors and transducers
- Frequency range from 0.05 Hz up to 9 MHz without prescaling and 144 MHz with prescaling;
- Programmable accuracy (relative error) for frequency (period) conversion from 1 % to 0.0005 %
- Relative quantization error is constant in all specified frequency range
- Non-redundant conversion time
- Scalable resolution
- Internal reference clock 625 kHz @ 20 MHz quartz oscillator
- Simplified and improved quartz-accurate automated calibration

Measuring Modes

- Frequency, f_x 0.05 Hz – 9 MHz directly and up to 144 MHz with prescaling
- Period, T_X 110 ns – 20 s
- Phase shift, φ_X 0 - 360º at f_{xmax}=625 kHz at 50 % duty-cycle
- Time interval between start – and stop-pulse, τ_X 1.5 µs – 250 s
- Duty-cycle, DC 0 – 1 at $f_{xmax} \leq 625$ kHz
- Duty-off factor, Q_1 10^{-8} – $8 \cdot 10^6$ at $f_{xmax} \leq 625$ kHz
- Frequency difference, $f_{X2} - f_{X2}$ with sign recognition, 0 – 9 MHz
- Period difference, $T_{X1} - T_{X2}$ with sign recognition, 0 – 20 s
- Frequency ratio, f_{X1}/f_{X2} $5.5 \cdot 10^{-9}$ – $1.8 \cdot 10^8$
- Period ratio, T_{X1}/T_{X2} $4.0 \cdot 10^{-9}$ – $2 \cdot 10^8$
- Rotation speed, $n_X = (f_X \cdot 60)/Z$, where Z is the number of encoder teeth
- Pulse width, t_P 1.5 µs – 250 s
- Space interval, t_S 1.5 µs – 250 s
- Pulse number (events) counting, N_X 0 – $4 \cdot 10^9$
- Frequency deviation absolute D_{A1}, 0-9 MHz
- Frequency deviation relative D_{R1}, 0-100 %
- Resistance, R_x 10 Ω to 10 MΩ with average relative error ±0.47 % and ±0.01 % error at splitting of the range into sub ranges
- Capacitance, C_x 50 pF to 100 µF with average relative error ±0.036 % and ±0.7 % the worst case relative error
- Resistive bridges, B_x must not include any internal components other than 4 arms forming a bridge

The USTI can also work with any voltage and current output sensors. It this case, any voltage–to-frequency converter (VFC) can be used. The accuracy of such system will be determined by sensor accuracy as well as by VFC accuracy.

The UFDC-1 is available as IP for the use in various microelectronic design. This device can be supplied also in wafer form.



Communication Modes

The USTI can work as an independent measuring unit (master mode), controlled by any external microcontroller (or embedded into a sensor), DAQ board or PC (slave mode). In the master mode, the conversion accuracy and measurement mode should be selected by external switches. In this mode the USTI works only through the RS232 interface in a unidirectional mode. In the slave mode (with an external microcontroller), all measuring modes and programmed accuracy can be set up by a data bus or through communication I/O ports of master microcontroller. This allows us use the USTI as a simple peripheral circuit for a microcontroller.

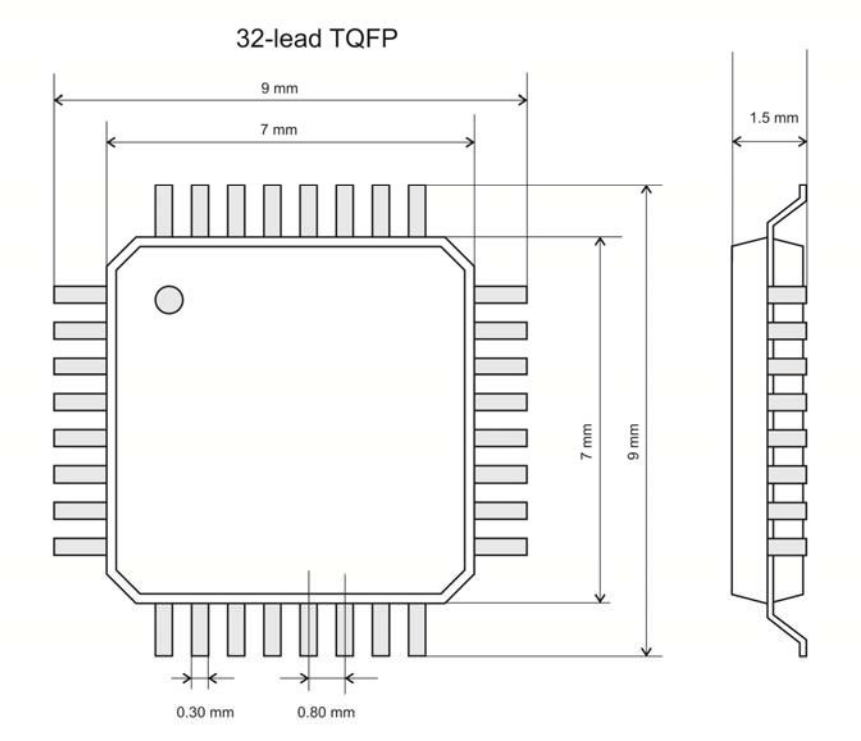
A bidirectional data exchange is possible with any of three interfaces RS232, SPI or I^2C. The USTI works as a standard element in different systems with I^2C bus architecture, or can be controlled through the RS232 or SPI interfaces. The choice of interface can be performed automatically depend on the circuit connections.

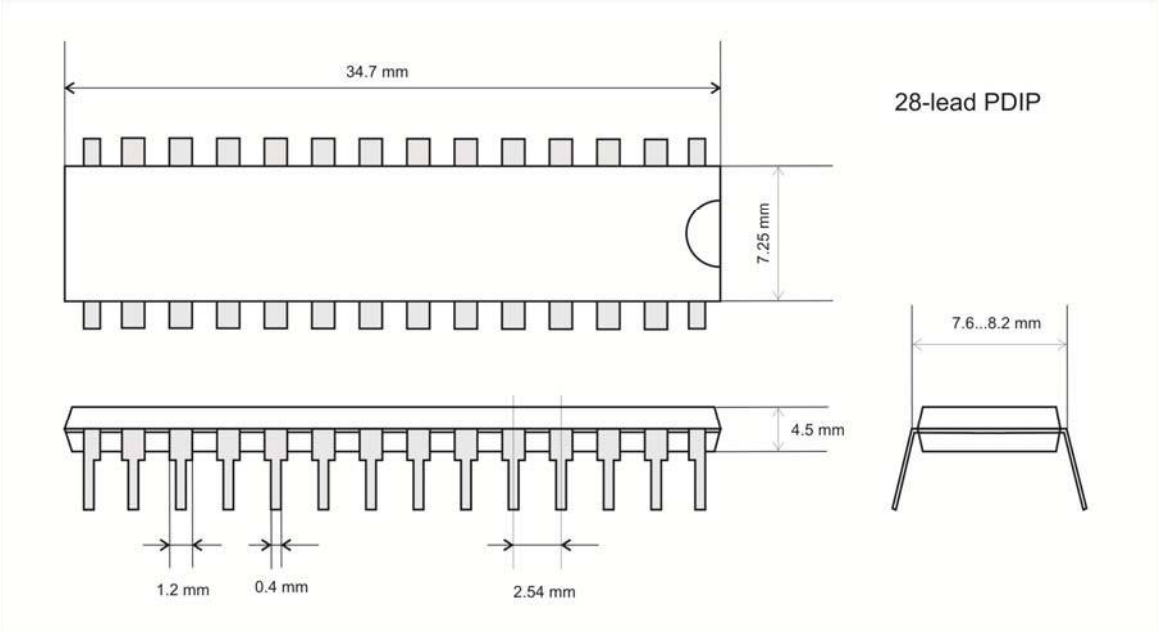
Applications

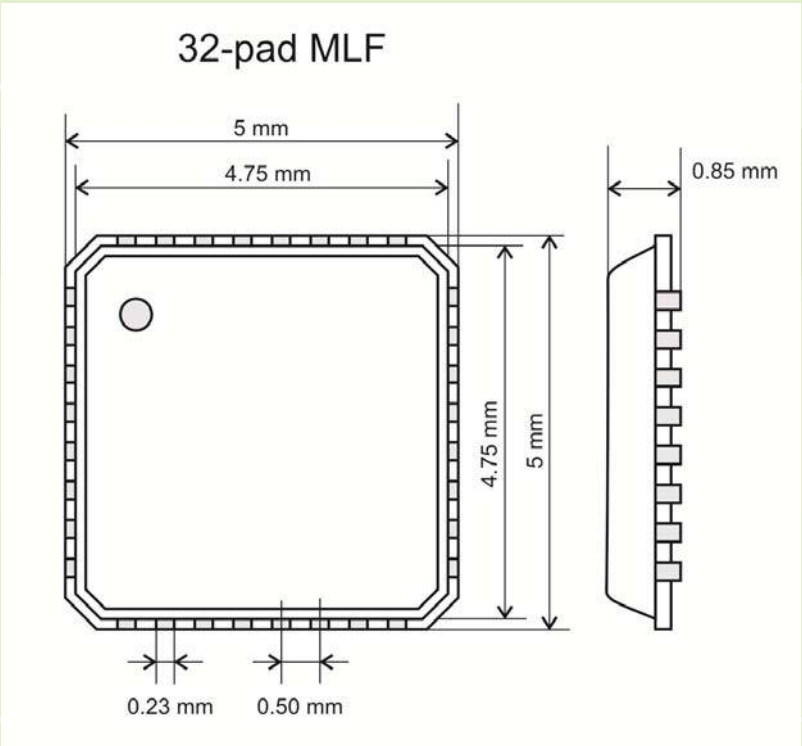
The USTI has many applications. Some typical applications are the following:

- Sensor systems with any frequency, period, duty-cycle, time interval, phase-shift, pulse number output sensors and transducers;
- Physical, chemical, bio- and immunosensors; quartz crystal microbalance (QCM) based sensors, BioMEMS, Lab-on-Chip;
- Digital sensors design, SoC, SiP;
- ADCs based on intermediate voltage-to-frequency conversion;
- Smart, intelligent (self-adaptive) sensors and sensor systems due to programmable accuracy and non-redundant conversion time - adaptive possibilities of USTI automatically choice the conversion time depending on the given error of measurement and opposite;
- Multifunctional and multiparameters sensors for simultaneous detection various parameters proportional to frequency and duty-cycle carrying the information provided by sensing elements;
- Data acquisition (DAQ) boars and measuring systems for frequency-time parameters of electric signal;
- Virtual instruments;
- Desktop multifunctional frequency counters;
- Tachometers and tachometric systems;
- Handheld multimeters for frequency-time parameters of electric signals;
- High-end, mid- and low-range ABS;
- High accuracy programmable frequency-time parameters – to – digital converters for various measuring and communication applications.

Packages




28-lead PDIP
34.7 mm
7.25 mm
7.6...8.2 mm
4.5 mm
1.2 mm
0.4 mm
2.54 mm


32-pad MLF
5 mm
4.75 mm
0.85 mm
4.75 mm
5 mm
0.23 mm
0.50 mm

Universal Sensors and Transducers Interface (USTI-EXT)

General Description

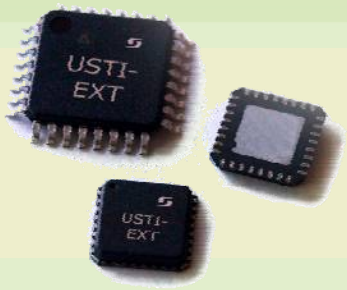
The Universal Sensors and Transducers Interface (USTI-EXT) is an integrated circuit with extended temperature range. The new IC has similar metrological performance as the TAB's integrated Universal Frequency-to-Digital Converter (UFDC-1M-16) and the same functionalities as the USTI IC but can work in extended operation temperature range from - 55 ^{0}C to +150 ^{0}C (AEC-Q100 Grade0).

In comparison with the basic USTI, the USTI-EXT has the reduced external clock frequency 16 MHz, but increased internal reference frequency from 625 kHz to 16 MHz, and as consequence, the reduced conversion speeds from 6.25 μs to 12.5 ms for relative errors from 1 % to 0.0005 % respectively.

The IC has also increased baud rate for the RS232 serial interface: up to 76 800. Active supply current does not exceed 12 mA. The IC is available in two packages: 32-lead, 7×7 mm, Thin Profile Plastic Quad Flat Package (TQFP) and 32-pad, 5 × 5 mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF).

Applications

The USTI-EXT IC is suitable for various applications including automotive, avionics, space and military. In all such applications, high metrological performances, reliability, robustness, high speed of measurement and operating efficiency will be achieved. This device enables designers to distribute intelligence and control functions directly into or near gearboxes, transfer cases, engine sensors actuators, turbochargers and exhaust systems. The ICs can be used for various quasi-digital (frequency, PWM, duty-cycle, etc. output) vehicle's sensors such as wheel speed sensor, vehicle speed sensor, turbine speed sensors, pressure sensors, fuel level sensors, mass air flow sensor, torque sensor, etc. In addition, the USTI-EXT IC is well suited for capacitance, resistance and resistive bridge types of sensors, which are also widely used in cars. Three different sensors can be connected directly to one IC.



ICs Comparison

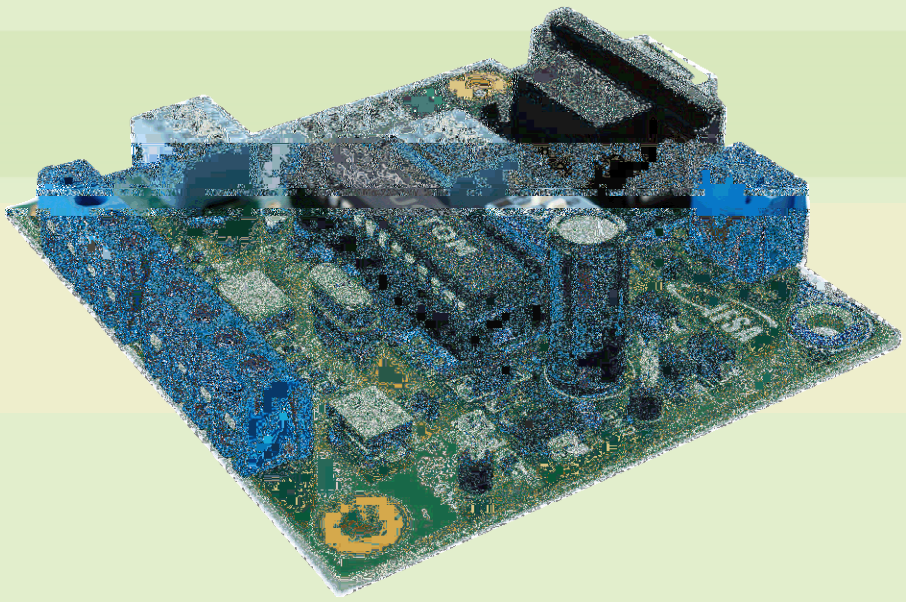
Relative error, %	UFDC-1	UFDC-1M-16	USTI	USTI-EXT
	t_{conv}, s			
1	0.0002	0.00000625	0.00016	0.00000625
0.5	0.0004	0.0000125	0.00032	0.0000125
0.25	0.0008	0.000025	0.00064	0.000025
0.1	0.002	0.0000625	0.0016	0.0000625
0.05	0.004	0.000125	0.0032	0.000125
0.025	0.008	0.00025	0.0064	0.00025
0.01	0.02	0.000625	0.016	0.000625
0.005	0.04	0.00125	0.032	0.00125
0.0025	0.08	0.0025	0.064	0.0025
0.001	0.2	0.00625	0.16	0.00625
0.0005	-	-	0.32	0.0125

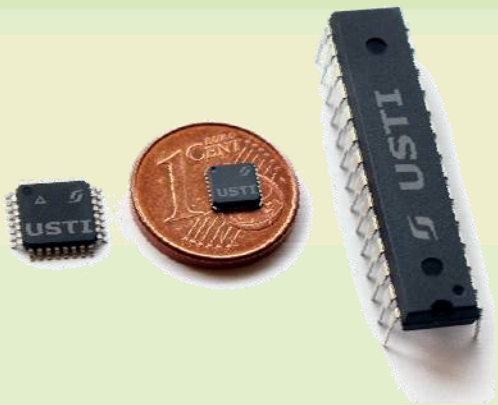
Custom Designed ICs

Custom design is available. The possibility of additional functions include but not restricted to:

- Additional measuring modes (for example, measuring mode with non-redundant reference frequency for low power applications, etc.)
- Additional mathematical operations for on-chip data and signal processing
- Various interfaces including parallel interface
- Increased accuracy, reduced conversion time and expanded frequency range
- IEEE 1451 standard support

Most of necessary functions can be implemented on a single circuit and so to provide a system-on-chip solution.

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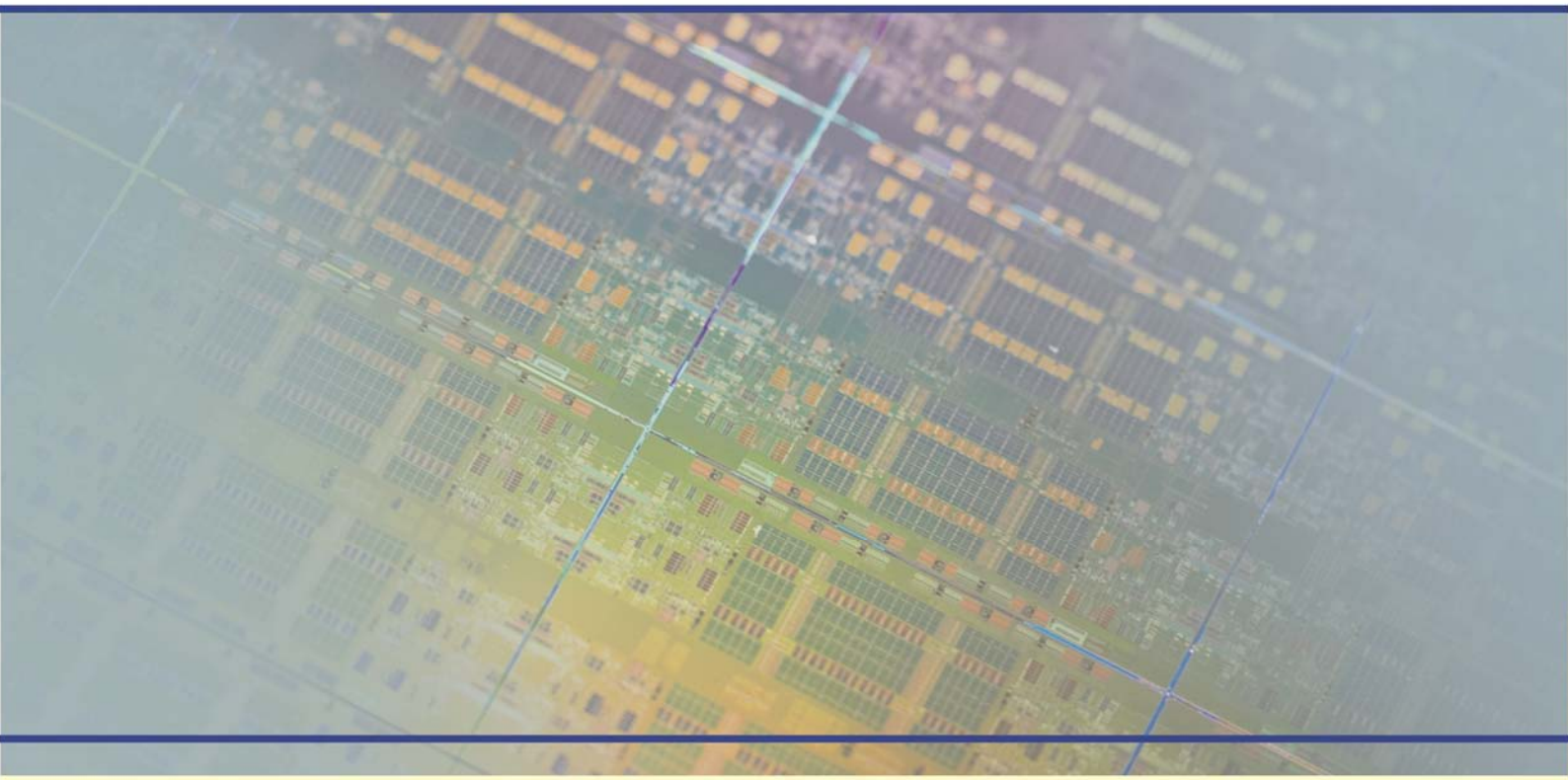

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