Universal Frequency-to-Digital Converter

UFDC-1

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**

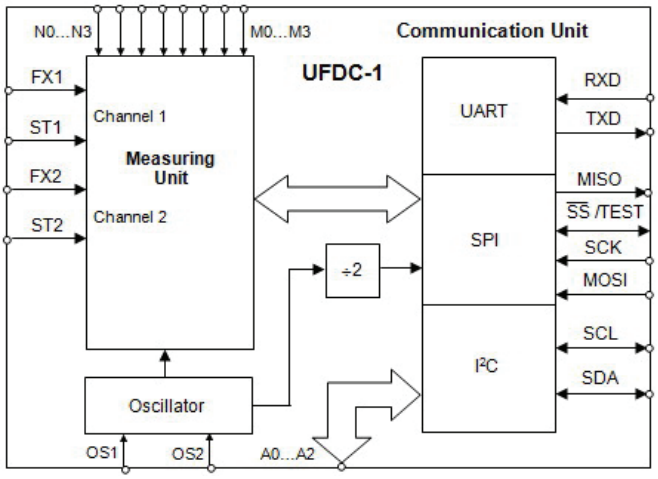
APPLICATIONS

Physical and Chemical Sensor Systems
Digital Sensors, SoC, SiP
Smart and Intelligent Sensors and Systems
Industrial and Process Control
Data Acquisition Systems
Instrumentations
Customer Electronics
Automotive

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.

FUNCTIONAL BLOCK DIAGRAM



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 I^2C) can be automatically selected according to the circuit connection.

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} $7 \cdot 10^{-9}$ – $1.4 \cdot 10^{8}$
- Period ratio, T_{x1}/T_{x2} $7.5 \cdot 10^{-9}$ – $1.33 \cdot 10^{8}$
- 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 – $4 \cdot 10^{9}$

NOTE: 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.

ACCURACY

The UFDC-1 has programmable relative error from 1 to 0.001 % in all specified range of frequencies for frequency and period measurements. This error is constant and does not depend on the measuring frequencies in all frequency ranges. The UFDC-1 has non-redundant conversion time. The higher conversion accuracy needs longer conversion time. However, it is non-redundant for any selected accuracy and frequency. For time interval, phase shift, pulse width and space measurements the relative error is determined mainly by measurand and can be calculated according to the following equation:

$$\delta_q = \frac{1}{16 \cdot 10^6 \cdot t_x} \times 100\%,$$

where t_x is the appropriate measuring value of t_p, t_s or τ_x depending on the mode.

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 I^2C. 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.

CHARACTERISTICS

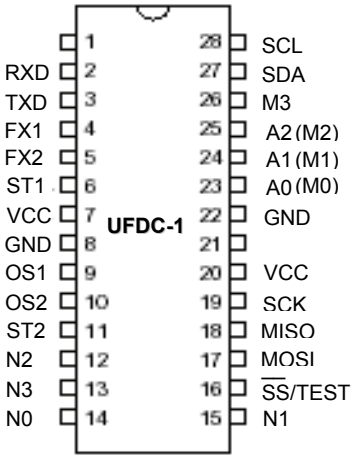
- Single power supply, V: 4.5 – 5.5
- External reference frequency, MHz: 16
- Internal reference frequency, kHz: 500
- Conversion time, s: 0.0002 to 0.2
- Supply current (at 16 MHz, 4.5V, 25ºC), mA: 17.5
- Operating temperature range -40ºC to +85ºC
- Storage temperature range -65°C to +150°C

PIN-OUT AND HOUSING

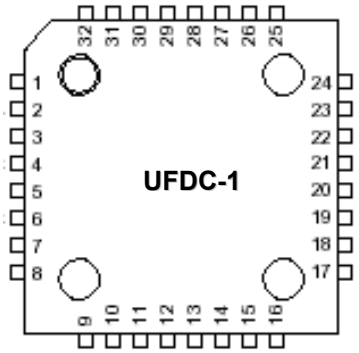
The UFDC-1 is available in a 28-lead (0.300"/7.62 mm Wide) Plastic Dual Inline Package (PDIP); 32-lead 7 x 7 mm Body Size, 1.0 mm Body Thickness, 0.8 mm Lead Pitch small Thin Profile Plastic Quad Flat Package (TQFP); and 32-pad, 5 x 5 x 1.0 mm Body, Lead Pitch 0.50 mm, 3.10 mm Exposed Pad, Micro Lead Frame Package (MLF).

PIN FUNCTION DESCRIPTIONS

PDIP



TQFP/MLF TOP VIEW



NOTE: Bottom Pad for MLF Package Should be Soldered to Ground.

Table. 1 Pin Function Description for TQFP/MLF packages.

Pin Number	Function	Pin Number	Function
1	FX2	17	SCK
2	ST1	18	VCC
3	GND	19	-
4	VCC	20	-
5	GND	21	GND
6	VCC	22	-
7	OS1	23	A0 (M0)
8	OS2	24	A1 (M1)
9	ST2	25	A2 (M2)
10	N2	26	M3
11	N3	27	SDA
12	N0	28	SCL
13	N1	29	-
14	SS/TEST	30	RXD
15	MOSI	31	TDX
16	MISO	32	FX1

This device can also be supplied in wafer form. Please contact Technology Assistance BCNA 2010 S. L. sales office for detailed ordering information and minimum quantities.

For more detailed information, specifications and application notes the following document are strongly recommended: *Universal Frequency-to-Digital Converter (UFDC-1): Specification and Application Note*

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