Preliminary Information

Application Brief

APPLICATIONS:

Steppers and Encoders

Home Appliance Controls Integrated with Voice Control

Smart Appliances

Home Security

Digital Telephone Answering Machine

Engine Management

Power Line Modem

Servo Drives

Automotive Control

Electric Lawn Equipment

Noise Cancellation

Internet Appliances

IP Phone

Modems

Magnetic Card Readers

Security

Digital Speakers

Voice Recognition Systems

“Hands-free” Kits

Digital Cameras

Telecom Test Equipment

Fuel Management Systems

and more. . . . .

Electronic Energy Meter with Powerline Modem on DSP56F80x

Electronic energy meters outperform the traditional Ferraris wheel meters in terms of functionality and performance. Cost and reliability are the main issues blocking their wider use at present. To be more attractive for customers the electronic meter must offer either more functionality or the cost must be decreased near the level of electromechanical solutions.

In the case of nonlinear loads, one of the very important advantages of electronic meters is their high metering accuracy. Electronic measurements are more robust and accurate under such conditions.

The DSP based meter can compute many electric parameters:

- Active power and energy
- Reactive power and energy
- Apparent power and energy
- Computations of maximum demands (peak power) and their archiving
- Multiple tariff counters
- RMS value of phase voltages and phase currents
- Frequency, power factor
- Higher harmonics analysis and more

Using DSP processors and ADC converters, high metering accuracy can be achieved. But the cost of such solutions is still high. The DSP56F80x DSP/MCU processor from Motorola has all required parts for such a system on a single chip. This leads to cost savings and simplifies the whole solution. A complete three-phase energy meter on DSP56F80x is shown in Figure 1. A similar schematic can be used for single or dual phase meters by omitting unnecessary current transformers and voltage dividers.

Of the DSP56F80x processor’s peripherals, among the most important are 2x4 channel fast simultaneous sampling 12-bit ADC, general purpose ports, timers, FLASH memory and microcontroller functionality at 40MIPS. On-chip FLASH is page erasable and can be used instead of the calibration EEPROM. The fast on-chip ADC enables analysis of power line disturbances and additional analysis not found on electromechanical and simple electronic meters.

Another new feature possible on this chip is the power line modem capability. The modem’s receive function uses the same voltage samples used for electric power computing. The transmit part uses on-chip PWM module followed by a buffer connected to one power phase.

The electric energy can be computed by following equation:

$$W = \int U \cdot I \cdot dt$$

In discrete time domain it is:

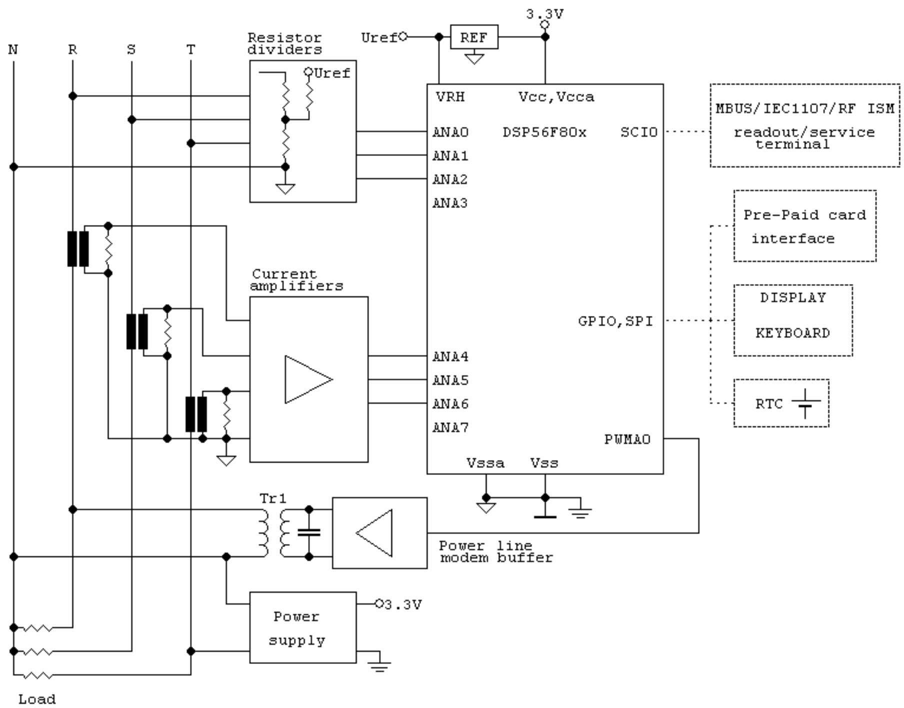
$$W = \sum_{t=0}^{\infty} i_n \cdot u_n \cdot \Delta t$$

u_n and i_n are voltage and current samples at time t, Δt is sampling interval

The on-chip ADC is capable of dual sampling simultaneously, so current and voltage are sampled together in each phase. Computing of the energy consists mainly of multiplying and adding operations handled by this DSP very easily. The high ADC sampling rate (up to two samples at 830kHz) contributes to high measuring accuracy even in the case of a nonlinear load.

Phase voltages are scaled down to the range of the ADC by resistor dividers. These dividers are modified by additional resistors. They bias the zero level input voltage to the middle of the ADC's range. The phase current is measured by current transformers while the input level is amplified by simple inverting OPAMs. Depending on current transformer type, software correction of the phase shift may be necessary before energy computation.

The power line modem is carried out in software. The DSP56F80x is powerful enough to operate filters, demodulator, transmit modulator and other necessary parts simultaneously with energy computing. The only additional component is a power line interface buffer with transformer. The buffer consists of the simple totem pole transistor stage. The transformer is used mainly for high voltage isolating. Primary winding coupled with a capacitor resonance circuit performs transmit postfiltering. These parts should be adapted according to the modulation scheme used. Appropriate modulations for this purpose are FSK in the frequency range 125-140kHz as specified by CENELEC or below 450kHz specified by FCC. Data rate is 1200-2400bps, sufficient for data collection from meters. For higher data rates a more sophisticated modulation scheme should be used.



Electric Energy Meter with Powerline Modem Schematic

There are additional optional blocks in Figure 1:

- Display, keyboard – can be connected through general purpose port pins (GPIOs) or through SPI
- Readout/service terminal – M-BUS cable interface or RF interface connected through SCI0 (UART)
- Pre-paid card interface – for energy delivery based on prepaid cards
- RTC – realtime clock for data logging time stamps and multi tariff billing

Because all parts are galvanically connected to power outlets, all user interfaces (if any) should be isolated by optocouplers.

The DSP56F80x from Motorola is a fully versatile part for a high performance, low cost, single chip electric energy meter with many additional features not found in other solutions.

DSP56F80X CUSTOMER SUPPORT:

Technical Support:
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1-800-521-6274

Website:
www.motorola.com/semiconductors/dsp

Literature Distribution Center for Motorola:
1-800-441-2447

Other Inquiries:
Contact your Motorola sales representative or authorized distributor

Disclaimer:
This sheet may not include all the details necessary to completely develop this design. It is provided as a reference only and is intended to demonstrate the variety of applications for the device.

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