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Evaluating the TERIDIAN 71M6511/71M6513 Demo Kits

The Demo Kits 71M6511-DB and 71M6513-DB are available from TERIDIAN. These kits enable the customer to evaluate the performance and features of the 71M6511/71M6513 power meter ICs. This application note describes the types of measurements and tests the customer can perform with the Demo Kits.

Introduction

The 71M6513/6513H Demo Board is a ready-to-use meter with a preprogrammed scaling factor Kh of 3.2. Similarly, the 71M6511/6511H Demo Board is a ready-to-use meter with a preprogrammed scaling factor Kh of 1.0. Various test and measurements can be performed with the Demo Kits, such as:

- Connecting the Demo Board to a meter calibration system and reading the pulse outputs as a function of power, power factor, harmonics.
- Connecting the Demo Board with the Debug Board and exercising commands of the demo code via the serial interface.
- Calibrating the Demo Board using a meter calibration system plus the commands via the serial interface.
- Evaluating electrical parameters
- Developing and modifying MPU code using the Signum ADM51 in-circuit-emulator.

While the first four tests stated above are relatively intuitive and do not require specialized equipment (except for a meter calibration system), the last three steps require a thermal chamber, an in-circuit emulator, compiler and other tools in addition to knowledge and experience in developing firmware for embedded systems.

It should be noted that the Demo Kits are not reference designs. The Demo Kits are designed solely to provide an easy to use vehicle for customers who want to evaluate the potential of the chips. All electrical properties that are a function of the board layout and of the components used on the Demo Board are the sole responsibility of the customer. No guarantees are made by TERIDIAN with respect to compatibility to standards or regulations.

Using the Demo Boards with a Meter Calibration System

In order to be used with a calibrated load or a meter calibration system, the Demo Board should be connected to the AC power source using the spade terminals on the bottom of the board. The current transformer(s) should be connected to the dual-pin headers on the bottom of the board. For the Kh to be adjusted properly, current transformers with 2,000:1 winding ratio must be used.

Once, voltage is applied and load current is flowing, the red LED D5 on the 71M6513 Demo Board will flash each time an energy sum of 3.2 Wh (or 1.0 Wh in the case of the 71M6511) is collected. The LCD display will show the accumulated energy in Wh when set to display mode 3 (command `>M3` via the serial interface).

Similarly, the red LED D6 will flash each time an energy sum of 3.2 VARh is collected (or 1.0 Wh in the case of the 71M6511). The LCD display will show the accumulated energy in VARh when set to display mode 5 (command `>M5` via the serial interface).

These values can be derived by reading the values for IMAX and VMAX, i.e. the RMS current and voltage values that correspond to the 250mV maximum input signal to the IC, which should be 208A and 600V (MPU addresses 0x09 will read 6000 and address 0x0A will read 2080), and inserting them in the following equation for Kh (the formulae and values are stated in the data sheets):

The Kh factor for the 71M6511 (i.e. energy per pulse) is determined by the following equation (**for Demo Code 3.04**):

$$Kh = VMAX * IMAX * 47.1132 / (\ln_8 * WRATE * N_{ACC} * X) \text{ Wh/pulse.}$$

Almost any desired Kh factor can be selected for the Demo Board by resolving the formula for WRATE:

$$WRATE = (IMAX * VMAX * 47.1132) / (Kh * \ln_8 * N_{ACC} * X)$$

X can be selected with *PULSE_FAST* and *PULSE_SLOW* to 0.09375, 1.5, 6, or 96. N_{ACC} is given by $PRE_SAMPS * SUM_CYCLES$ (see the 71M6511 Datasheet for further details)

For example, if a Kh of 2.0Wh/pulse is desired, and $X = 1.5$, $\ln_8 = 1$, $N_{ACC} = 2520$, WRATE is calculated to:

$$WRATE = (208 * 600 * 47.1132) / (2.0 * 1 * 2520 * 1.5) = 777.6$$

The value 778 (decimal) should be entered for WRATE at location 2D (command **>]2D=+778**).

The Kh factor (i.e. energy per pulse) for the 71M6513 is determined by the following equation (**in Demo Code 3.04**):

$$Kh = VMAX * IMAX * 66.1782 / (\ln_8 * WRATE * N_{ACC} * X) \text{ Wh/pulse.}$$

Almost any desired Kh factor can be selected for the Demo Board by resolving the formula for WRATE:

$$WRATE = (IMAX * VMAX * 66.1782) / (Kh * \ln_8 * N_{ACC} * X)$$

X can be selected with *PULSE_FAST* and *PULSE_SLOW* to 0.09375, 1.5, 6, or 96. N_{ACC} is given by $PRE_SAMPS * SUM_CYCLES$ (see the 71M6513 Datasheet for further details).

For example, if a Kh of 1.0Wh/pulse is desired, and $X = 1.5$, $\ln_8 = 1$, $N_{ACC} = 2520$, WRATE is calculated to:

$$WRATE = (208 * 600 * 66.1782) / (1.0 * 1 * 2520 * 1.5) = 2185.9$$

The value 2185 (decimal) should be entered for WRATE at location 2D (command **>]2D=+2185**).

Note: Some Demo Boards come with toggle switches labeled “PULSE RATE SELECT FAST/SLOW”. These switches are not functional. If a switch is installed on a Demo Board, it should always be kept in the lower position (to prevent DIO3 [6513] or DIO17 [6511] from being shorted to ground).

Basic function of the Demo Board can be verified by operating the meter calibration system at various power and power factor levels while observing the pulse outputs and LCD. It should be noted that the Demo Kits are shipped as uncalibrated units, thus deviations from ideal accuracy between 3% and 5% are to be expected.

Testing the response to harmonics is another relevant test. The Demo Board does not necessarily have to be calibrated in order to conduct harmonics tests, as long as relative deviation of results due to the presence of harmonics is evaluated

Adjusting the Kh Factor for the Demo Boards

Almost any desired Kh factor can be selected for the Demo Board by resolving the formulae given above for WRATE:

$$WRATE = (IMAX * VMAX * 47.1132) / (Kh * In_8 * N_{ACC} * X) \quad [71M6511/6511H]$$

$$WRATE = (IMAX * VMAX * 66.1782) / (Kh * In_8 * N_{ACC} * X) \quad [71M6513/6513H]$$

The value for WRATE should be entered at location 2D (command >]2D=*WRATE* via the serial interface)

Adjusting the Demo Boards to Different Current Transformers

The Demo Board is designed for use of 2000:1 current transformers. This means that in the original Demo Board, 208A on the primary side at 2000:1 ratio result in 104mA on the secondary side, causing 177mV at the 1.7Ω resistor R24/R25, R36/R37, R56/R57 (2 x 3.4Ω in parallel).

The steps required to adapt a 6511 Demo Board to a transformer with a winding ratio of 2500:1 are outlined below:

- 1) 208A at 2500:1 result in 83.2mA on the secondary side, causing only 141mV. **Changing the resistors R24/R25, R36/R37, R56/R57 to a combined resistance of 2.127 Ohm** (for each pair) will cause the desired voltage drop of 177mV appearing at the IA, IB, and IC inputs of the 6511 chip.
- 2) WRATE should be adjusted to achieve the desired Kh factor, as described in 1.6.3.

Simply scaling IMAX is not recommended, since peak voltages at the 71M6511 inputs should always be in the range of 0 through ±250mV. If a CT with a much lower winding ratio than 1:2,000 is used, higher secondary currents will result, causing excessive voltages at the 71M6511 inputs. Conversely, CTs with much higher ratio will tend to decrease the useable signal voltage range at the 71M6511 inputs and may thus decrease resolution.

Calibrating the Demo Boards

Before the calibration procedure is started, communication with the Demo Boards must be established. This is best done by following the procedures given in sections 1.5.1 through 1.5.4 of the Demo Board User's Manual. The most important points of these sections are reiterated below:

- Work with the Demo Board and Debug Board removed from high voltage until communication is established and the user is familiar with the serial communication command set.
- Use the isolation offered by the Debug Board, with the Debug Board powered separately, and jumpers JP2 and JP3 removed from the Demo Board.
- Use the file Demo Board Connection.ht supplied on the CD-ROM that comes with the Demo Kit to set up the communication parameters of the HyperTerminal program.
- Check the jumper settings as described in section 1.5.3 of the Demo Board User's Manuals if communication cannot be established.

The calibration routine is described in detail in the Demo Board User's Manuals.

Exercising Commands of the Demo Code via the Serial interface

The command interface offered by the demo code is most useful in understanding and evaluating aspects of the 71M6513 and 71M6511 meter chips. The following actions may be taken in this context:

- Observing output values and/or modifying input values of the CE
- Observing output values and/or modifying input values of the MPU
- Manipulating values in the I/O RAM

It is possible to evaluate many aspects of the 71M6513 and 71M6511 meter chip functionality without having to change the code. Both CE and MPU code may be controlled by modifying memory locations, such as *WRATE*, *SAG_THR*, *SAG_CNT*, *EXT_PULSE*, *CREEP_THR*, *CONFIG*, etc. In addition, *VMAX* and *IMAX* may be modified to adapt the Demo Board to different external components, and *PPMC/PPMC2* may be modified to experiment with the temperature compensation mechanism.

The I/O configuration of the chip may be modified and various power saving modes may be evaluated by changing the entries in the I/O RAM.

Developing and Modifying MPU Code

A variety of applications can be implemented with the 71M6513 and 71M6511 meter chips. TOU, optical communication, use of the SSI/SPI/I2C interfaces, chip outputs in case of tampering attempts, and many more applications are not part of the standard command set offered by the demo code. However, customers who wish to develop their own software are supported by a variety of library routines that exist as part of the demo code. Please refer to the Software User's Guide for further information.

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