TE851

Technical Manual

CONTENTS

MULTIFUNCTION METER FOR INDUSTRY

TE851

Technical Manual

GENERAL

High precision multifunction meter TE851 is a combination of well proven Iskra measuring system for high precision meters (known in TExxx meter family) and also well proven multifunction module developed for MT8xx meter family. This combination provides reliable measurements and many new functions typical for deregulated energy market.

TE851 is an electronic four-quadrant transformer rated electricity meter, for measurement and registration of active and reactive energy as well as active and reactive demand. The meter is mainly intended for large and medium size commercial and industrial customers.

TE851 characteristics:

- **Wide spectrum of the multifunction meter versions assembled and programmed according to customer specification**
- **Time-of-use registration of energy and demand in up to 8 tariff rates**
- **Measuring of active energy (import, export), reactive energy (four quadrants, combined quadrants) and apparent energy as well as corresponding demands**
- **All quantities are measured three-phase**
- **Load profile registration of demands and other quantities**
- **Possibility of load control at the consumer's side**
- **LCD displaying a variety of data, alarms and meter status**
- **High metering accuracy and long-term metering stability**

Connection: The meter is intended for CT or CT/VT connection in three or four-wire networks with class 0.2S/0.5S transformers.

Standards: Measuring, functional and physical characteristics of TE851 comply with the IEC 60687 standard requirements for active energy and IEC 61268 for reactive energy.

Special requirements: The TE851 meter design complies with VDEW-Lastenheft "Elektronische Elektrizitätszähler", Version 2.0 (12.97)

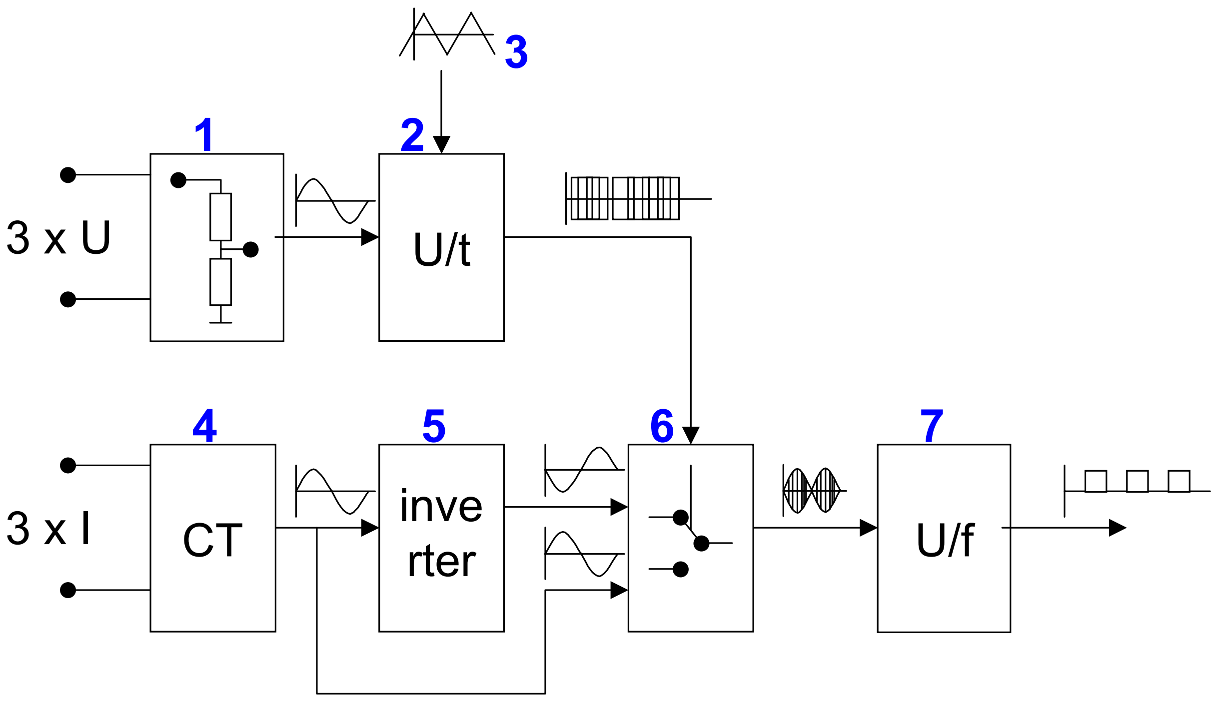
1. METERING STAGE

Measuring and technical characteristics of the meter comply with the IEC 60687 and IEC 61268 standard for static meters of classes 0.2S and 0.5S. Active and reactive energy meters are manufactured in both accuracy classes.

1.1. BASIC MEASURING PRINCIPLE

A measuring principle is based on Time Division Multiplication (TDM). TDM is an electronic measuring technique which produces an output signal proportional to two inputs, in our case voltage and current. The width or duration of the output signal is proportional to voltage and the height is proportional to the current. The area of the signal is then proportional to the product of the two inputs, power.

Measuring voltage is dropped down to the level which is convenient for electronics by means of resistor dividers (1). Voltage/time (U/t) conversion is performed in a multiplier (2) by means of delta voltage (3). The impulse witdh is proportional to the input voltage.
Measuring currents are converted to voltage signals, convenient for electronics, by means of electronically compensated current transformers (4). They are electrically isolated from mains network and limit secondary voltage in case of primary short circuit.
For measurement of reactive energy with artificial connection a required phase shift is formed (5). On request, it is possible also to use natural connection. Instantaneous values of voltage and currents, obtained via voltage dividers and current transformers, are multiplied by a "Time Division Multiplication" method (6). Multiplier voltage is converted to frequency (a string of successive impulses suitable for further processing) by a method of balance charges (7) which is proportional to energy.

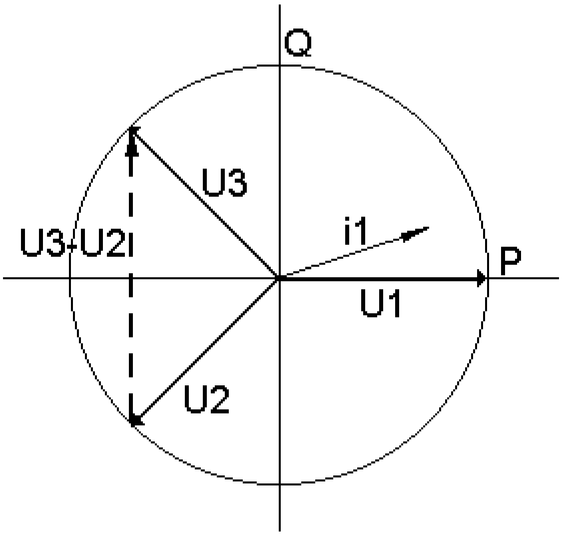


1. Voltage dividers
2. Voltage/time
3. Delta voltage generator
4. Current transformers
5. Voltage phase shift
6. U x I Multiplier
7. Voltage/frequency converter

1.2. ARTIFICIAL AND NATURAL CONNECTION

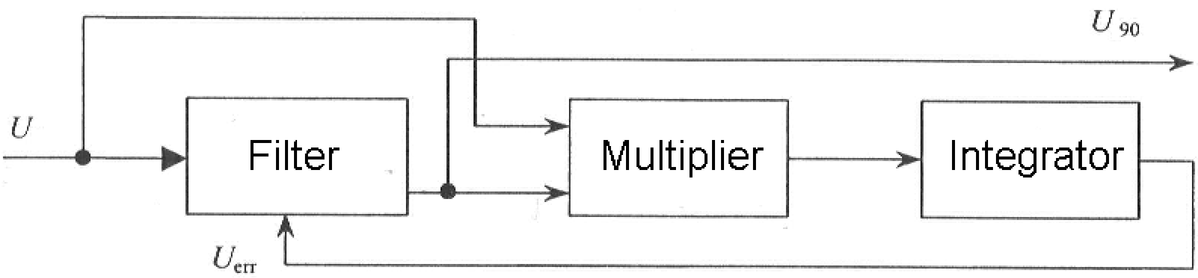
Artificial and natural connection are used for reactive energy measurement.
In most cases, artificial connection is used which is based on symmetric three-phase system. Current of the first phase is multiplied with a voltage difference of the second and the third phase voltage. The result of a multiplication is reactive energy. The same is for other two phase currents.

Drawback of the artificial connection is that it requires all three phases and precision depends on a symmetric of the three-phase system.



With a natural connection, we have single phase reactive energy measurement. For each phase the current and 90º shifted voltage are multiplied.
Phase voltage (U) is shifted for angle 90º by controlled filter. Control loop includes multiplier and integrator. Phase voltage (U) is multiplied with a shifted voltage (U_{90}) from filter output and sent to integrator. Filter is corrected by output from integrator. If voltages are shifted for 90º the result of integration must be null.

In a case of the phase failure or unsymmetric voltage system, information about reactive energy is still correct for each phase.



1.3. METERING DATA PROCESSING AND STORAGE

The quantified pulses from the metering elements are fed to the microcomputer for further processing (e.g. calculation of apparent energy, energy consumption, demands, etc.) and data storage (TOU and load profile registration etc.).

The microcomputer consists of 128k FLASH memory, 32k SRAM or 128k SRAM, 8k EEPROM and LCD driver.

The meter software (including firmware) and configuration parameters are stored in the FLASH memory. All metering and calculated three-phase data are stored in the SRAM. Their historical values for up to 50 previous months as well as load profile and logbook data are stored there, too. Different events can be registered in the logbook. In case of power shortage all metering and calculated data are stored in the EEPROM where they can be kept for years without external power supply of the meter. The EEPROM can be written 100.000 times. All relevant data are stored on two locations - as an original and its copy. Both of them are refreshed every four hours. Data refreshment of originals and copies is shifted for two hours.

The LCD driver drives the custom designed VDEW display.

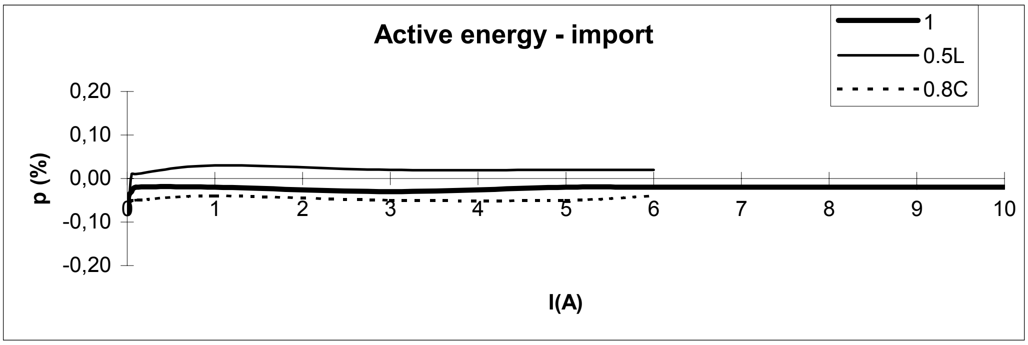
The microcomputer enables two-way communication with the meter via an infrared optical port, CS, and RS232 or RS485 serial interface. When metering data are down-loaded from the meter they are reed from the SRAM.

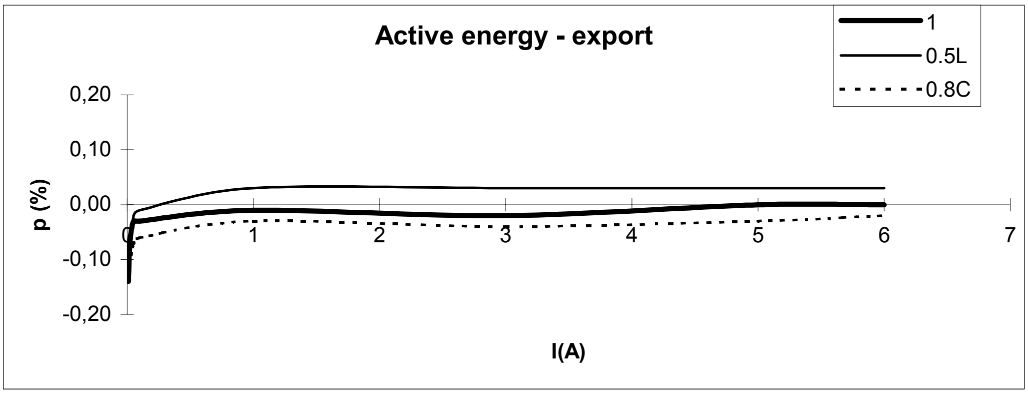
The microcomputer can also monitor different conditions in the network (power shortage, absence of line-to-neutral voltages, excess of contractual demand, etc.) and alarms if they has occurred. The microcomputer can also control an external actuator for limiting demand if this function was implemented into the meter.

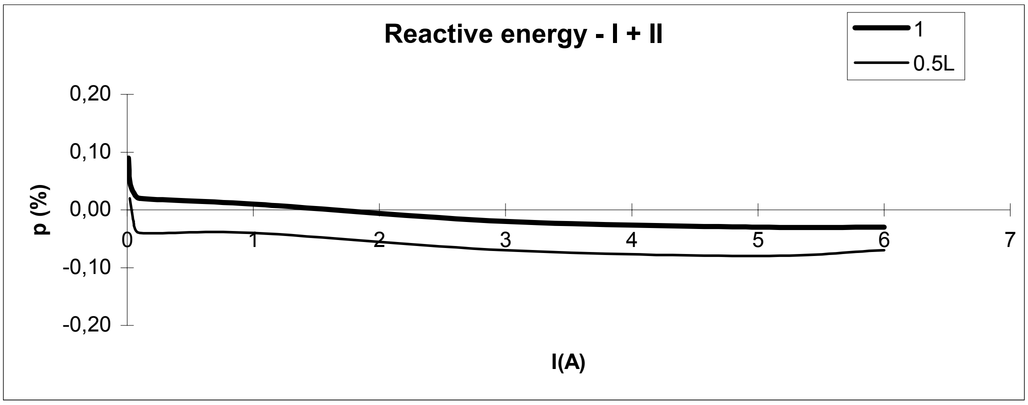
A watchdog circuit supervises the microcomputer functioning.

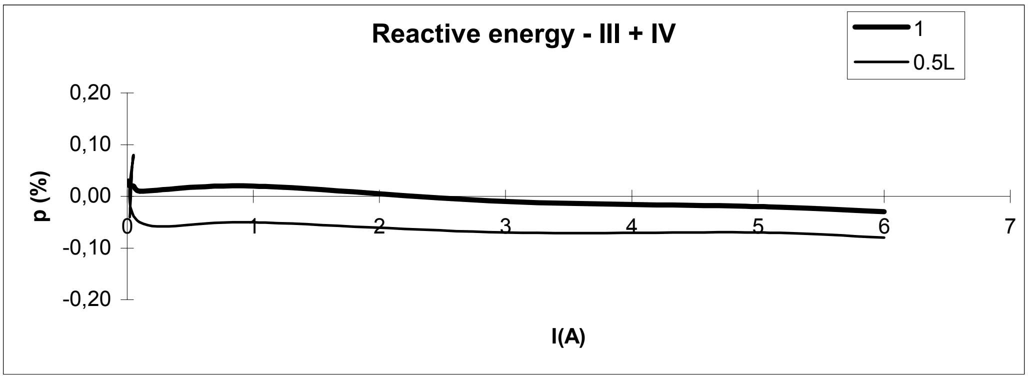
1.4. TYPICAL METER CURVES

1.4.1. Load curves





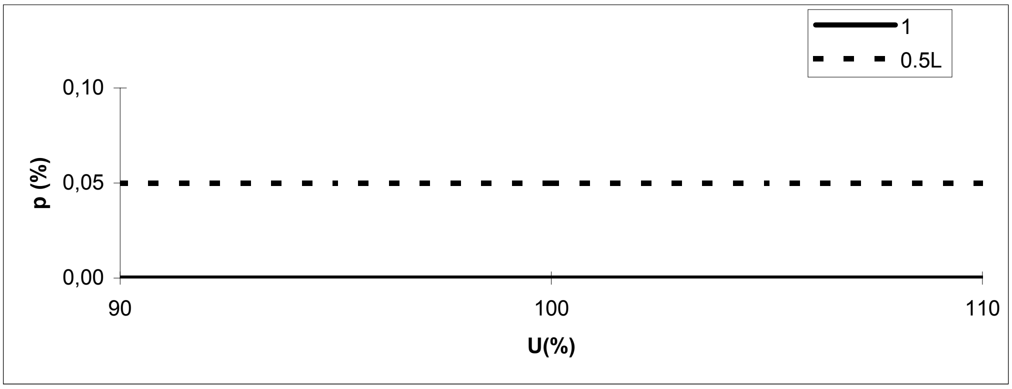




1.4.2. Influence quantities

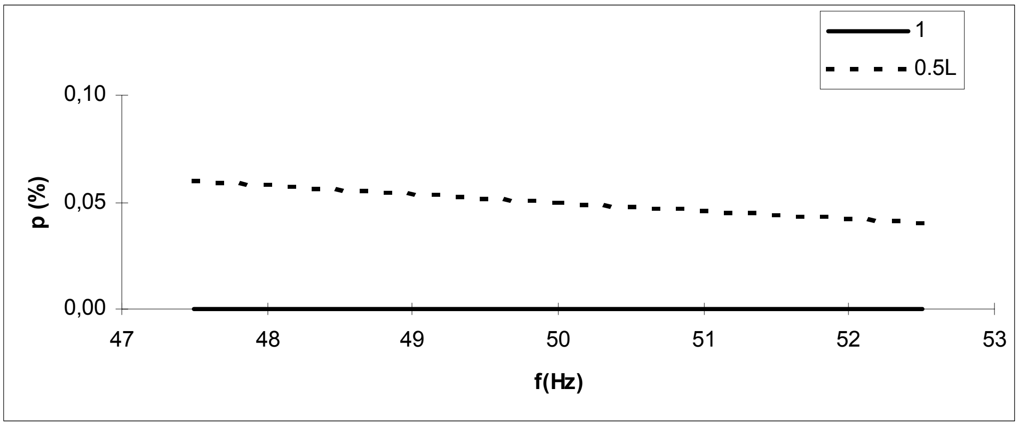
Voltage variation influence:

$I = I_n$



Frequency variation influence:

$I = I_n$



2. ENERGY MEASUREMENT

2.1. TYPES OF MEASURED ENERGY

The TE851 meters measure the following types of energy:

- imported and exported active energy: +A and -A,
- reactive energy in four quadrants: R_1, R_2 , R_3 and R_4,
- reactive energy in combined quadrants: e.g. Rp= $R_1 + R_2$ and Rn= $R_3 + R_4$,
- all energies are measured three-phase

2.1.1. Total energies

The TE851 meters enable measurement of up to 6 different total energies.

EDIS code	Name of quantity
1.8.0	Three-phase total imported active energy +A
2.8.0	Three-phase total exported active energy -A
5.8.0	Three-phase total reactive energy in 1-st quadrant R_1
6.8.0	Three-phase total reactive energy in 2-nd quadrant R_2
7.8.0	Three-phase total reactive energy in 3-rd quadrant R_3
8.8.0	Three-phase total reactive energy in 4-th quadrant R_4

Note
The TE851 meters that are not intended for a complete 4-quadrant measurement, measure only requested types of three-phase total energies.

2.1.2. Tariff rated energies

The TE851 meters enable measurement of up to 24 different tariff rated energies. Up to 8 different tariff rates can be defined. The following tariff rated energies can be measured:

- active energy import and export: +A and -A
- reactive energy in four-quadrants: R_1, R_2, R_3 and R_4 or reactive energies in combined quadrants: e.g. Rp = $R_1 + R_2$ and Rn = $R_3 + R_4$

EDIS code	Name of quantity
1.8.1	Three-phase energy, tariff 1, register 1
5.8.1	Three-phase energy, tariff 1, register 2
8.8.1	Three-phase energy, tariff 1, register 3
1.8.2	Three-phase energy, tariff 2, register 1
5.8.2	Three-phase energy, tariff 2, register 2
8.8.2	Three-phase energy, tariff 2, register 3
1.8.3	Three-phase energy, tariff 3, register 1
5.8.3	Three-phase energy, tariff 3, register 2
8.8.3	Three-phase energy, tariff 3, register 3
1.8.4	Three-phase energy, tariff 4, register 1

5.8.4	Three-phase energy, tariff 4, register 2
8.8.4	Three-phase energy, tariff 4, register 3
1.8.5	Three-phase energy, tariff 5, register 1
5.8.5	Three-phase energy, tariff 5, register 2
8.8.5	Three-phase energy, tariff 5, register 3
1.8.6	Three-phase energy, tariff 6, register 1
5.8.6	Three-phase energy, tariff 6, register 2
8.8.6	Three-phase energy, tariff 6, register 3
1.8.7	Three-phase energy, tariff 7, register 1
5.8.7	Three-phase energy, tariff 7, register 2
8.8.7	Three-phase energy, tariff 7, register 3
1.8.8	Three-phase energy, tariff 8, register 1
5.8.8	Three-phase energy, tariff 8, register 2
8.8.8	Three-phase energy, tariff 8, register 3

2.1.3. Calculated quantities

The TE851 meters are provided with registers where up to 32 different calculated quantities are registered, e.g. apparent energies and their demands.

Apparent energies are calculated from one of the following equations:

a. $$\mathbf{S = \sqrt{A^2 + R^2}}$$

b. $$\mathbf{S = \sqrt{A^2 + (R_i + R_j)^2}}$$

where: **A** is active energy, **R** is reactive energy $\mathbf{R_i}$ and $\mathbf{R_j}$ (i= 1, 2, 3, 4 and j=1, 2, 3, 4) are reactive energies in one of the four quadrants that makes sense to calculate apparent energy. Both active and reactive energies can be total or tariff rated.

2.1.4. Registration of energies in previous billing periods

All energies, which are measured by the meter, are stored in the corresponding registers for a current billing period (month). Metering data from registers for a current metering period are transferred into the corresponding registers of the previous billing period when meter is reset at the end of a billing period. Metering values stored in registers of previous billing periods are so called previous values.

Data on energy can be registered as:

- Differential value: a difference between cumulative values in two successive billing periods,
- Cumulative value: a cumulative value from a beginning of the energy measurement

Example
Value of total energy in a register of a current billing period was 65000kWh at billing reset of the meter; total value of the same energy was 62500 kWh at the end of a previous billing period.

In case of differential value registration in the register will be stored: 2500 kWh.
In case of cumulative value registration in the register will be stored: 65000 kWh.

Note
When ordering a meter define a mode of energy registration in registers of previous billing periods.

2.1.5. A number of previous billing periods

The TE851 meters enable registration of metering data for the last 15 billing periods if not requested otherwise. On request metering data for up to 50 previous billing periods can be stored in the meter. All data stored in the registers for previous billing periods can be both displayed on the LCD and transferred via the communication interfaces.

Note
A number of previous billing periods for which metering data are stored in the meter should be specified when ordering the meter.

2.2. A PROCEDURE OF ENERGY MEASUREMENT

2.2.1. Microprocessor

Measuring pulses from a metering stage of the kWh- and kvarh-meter are for three-phase. The pulses are quantified, i.e. every pulse represent an exact amount of energy. The pulses and energy flow direction data are fed to the microprocessor for further processing.

	3-phase	*3-phase*
Energy	*A*	*R*
Direction	*DA*	*DR*

A - a total number of increments of active energy in all three phases

R - a total number of increments of reactive energy in all three phases

DA - a direction of total active energy in all three phases

DR- a direction of total reactive energy in all three phases

2.2.2. Constant for energy measurement

Pulses fed to the microcomputer represent fixed energy quantity, which depends on particular meter configuration and is called sensor constant $\mathbf{k_{sens}}$. The constant is defined in the factory by calibration of the meter.

All metering values are stored in a raw binary form in the microprocessor. On the other hand, the TE851 meters that are connected via current or current and voltage transformers enable the metering data to be displayed in semi-primary or secondary value. Moreover, the meters connected via CT and VT enable compensation of the voltage transformer error. Therefore it is necessary to multiply the raw binary data with a metering constant $\mathbf{k_{mc}}$ that is calculated from the following equation:

$$k_{mc} = \mathbf{k_{sens}} / (k_{CT} * k_{VT})$$

where:

k_{CT} - is a current transformer ratio

k_{VT} - is a product of a voltage transformer ratio and voltage transformer error compensation.

A current transformer ratio $\mathbf{k_{CT}}$ is an integer in a range from 1 to 30,000 and is stored in a register 0.4.2.

A product of voltage transformer ratio and error compensation of voltage transformer $\mathbf{k_{VT}}$ is a number with a floating decimal point and is stored in a register 0.4.3. If no voltage transformer error compensation is required, the $\mathbf{k_{VT}}$ is equal to voltage transformer ratio.

3. DEMAND MEASUREMENT

The TE851 meters calculates instantaneous values of demands in the demand period and register the maximum ones in a billing period.

3.1. MEASUREMENT OF MAXIMUM DEMAND

Demand P_d is calculated as a quotient of energy integrated over a period of time and the time period. Therefore it is an average value. The period of energy integration is called a demand period T_{dp}. Maximum demand is the largest demand in a billing period (a time span between two billing resets of the meter).

The TE851 meters calculate momentary value of demand $\mathbf{P_{cd}}$ over elapsed time in a current demand period. At the end of the demand period the momentary value of demand is equal to the demand, i.e.

$\mathbf{P_{cd} = P_d}$.

At the end of each demand period a new demand $\mathbf{P_d}$ is compared with a current maximum demand $\mathbf{P_{md}}$ stored in a corresponding register of a maximum demand for a current billing period. If it is larger, it is stored in the register otherwise it is neglected. If it is stored in the maximum demand register then date and time when the demand period has ended are stored in corresponding registers too. In such a way in the register is stored a maximum demand at the end of a billing period as well as date and time when the demand period has ended.

At the billing reset maximum demand for a current billing period is transferred into the corresponding register for a previous billing period and the register of maximum demand in a current billing period is cleared. A routine of maxim demand calculation for a new billing period is started from the beginning.

A maximum demand can be calculated for all energies that are measured or calculated, i.e.:

- demand of imported and exported active energy: +P and -P
- demand of reactive energy in four quadrants: Q_I, Q_2, Q_3 and Q_4,
- demand of reactive energy in combined quadrants: e.g. $Qp=Q_I+Q_2$ and $Qn=Q_3+Q_4$,
- demand of imported and exported apparent energy: +S and -S.

Date and time of the end of maximum demand (so called time stamp) are stated by each maximum demand.

Note
If a time stamp is not required, this should be requested by the order.

3.1.1. Tariff rated maximum demand

The TE851 meters enable measurement of up to 24 different tariff rated maximum demands. Up to 8 different tariff rates can be defined. For each tariff 3 registers are available. Note that tariff changeover schedule for demands can differ from the one for energies. The following tariff rated maximum demands can be calculated:

- demand of imported and exported active energy import: +P and -P
- demand of reactive energy in four-quadrants: Q_1, Q_2 , Q_3 and Q_4
- demand of reactive energies in combined quadrants: e.g. Qp = $Q_1 + Q_2$ and Qn = $Q_3 + Q_4$

EDIS code	Name of quantity
1.6.1	3-phase tariff rated maximum demand, tariff 1, register 1
5.6.1	3-phase tariff rated maximum demand, tariff 1, register 2
8.6.1	3-phase tariff rated maximum demand, tariff 1, register 3
1.6.2	3-phase tariff rated maximum demand, tariff 2, register 1
5.6.2	3-phase tariff rated maximum demand, tariff 2, register 2
8.6.2	3-phase tariff rated maximum demand, tariff 2, register 3
1.6.3	3-phase tariff rated maximum demand, tariff 3, register 1
5.6.3	3-phase tariff rated maximum demand, tariff 3, register 2
8.6.3	3-phase tariff rated maximum demand, tariff 3, register 3
1.6.4	3-phase tariff rated maximum demand, tariff 4, register 1
5.6.4	3-phase tariff rated maximum demand, tariff 4, register 2
8.6.4	3-phase tariff rated maximum demand, tariff 4, register 3
1.6.5	3-phase tariff rated maximum demand, tariff 5, register 1
5.6.5	3-phase tariff rated maximum demand, tariff 5, register 2
8.6.5	3-phase tariff rated maximum demand, tariff 5, register 3
1.6.6	3-phase tariff rated maximum demand, tariff 6, register 1
5.6.6	3-phase tariff rated maximum demand, tariff 6, register 2
8.6.6	3-phase tariff rated maximum demand, tariff 6, register 3
1.6.7	3-phase tariff rated maximum demand, tariff 7, register 1
5.6.7	3-phase tariff rated maximum demand, tariff 7, register 2
8.6.7	3-phase tariff rated maximum demand, tariff 7, register 3
1.6.8	3-phase tariff rated maximum demand, tariff 8, register 1
5.6.8	3-phase tariff rated maximum demand, tariff 8, register 2
8.6.8	3-phase tariff rated maximum demand, tariff 8, register 3

The TE851 meters enable registration of all maximum demands for the last 50 billing periods. All data stored in registers for previous billing periods can be both displayed on the LCD and transferred via the communication interfaces.

Note
If a number of previous billing periods is not specified with the order, their number is limited to 15 by the manufacturer.

3.1.2. Cumulative tariff rated maximum demands

The TE851 meters enable registration of up to 24 different cumulative tariff rated maximum demands. Up to 8 different tariff rates can be defined. For each tariff 3 registers are available. Note that tariff changeover schedule for demands can differ from the one for energies.

Cumulative maximum demands are checking values and are sums of the corresponding maximum demands registered in all completed billing periods since the beginning of the measurement.

Therefore there are no registers for cumulative maximum demands for previous billing periods. The following cumulative tariff rated maximum demands can be calculated:

EDIS code	Name of quantity
1.2.1	Cumulative tariff rated max. demand, tariff 1, register 1
5.2.1	Cumulative tariff rated max. demand, tariff 1, register 2
8.2.1	Cumulative tariff rated max. demand, tariff 1, register 3
1.2.2	Cumulative tariff rated max. demand, tariff 2, register 1
5.2.2	Cumulative tariff rated max. demand, tariff 2, register 2
8.2.2	Cumulative tariff rated max. demand, tariff 2, register 3
1.2.3	Cumulative tariff rated max. demand, tariff 3, register 1
5.2.3	Cumulative tariff rated max. demand, tariff 3, register 2
8.2.3	Cumulative tariff rated max. demand, tariff 3, register 3
1.2.4	Cumulative tariff rated max. demand, tariff 4, register 1
5.2.4	Cumulative tariff rated max. demand, tariff 4, register 2
8.2.4	Cumulative tariff rated max. demand, tariff 4, register 3
1.2.5	Cumulative tariff rated max. demand, tariff 5, register 1
5.2.5	Cumulative tariff rated max. demand, tariff 5, register 2
8.2.5	Cumulative tariff rated max. demand, tariff 5, register 3
1.2.6	Cumulative tariff rated max. demand, tariff 6, register 1
5.2.6	Cumulative tariff rated max. demand, tariff 6, register 2
8.2.6	Cumulative tariff rated max. demand, tariff 6, register 3
1.2.7	Cumulative tariff rated max. demand, tariff 7, register 1
5.2.7	Cumulative tariff rated max. demand, tariff 7, register 2
8.2.7	Cumulative tariff rated max. demand, tariff 7, register 3
1.2.8	Cumulative tariff rated max. demand, tariff 8, register 1
5.2.8	Cumulative tariff rated max. demand, tariff 8, register 2
8.2.8	Cumulative tariff rated max. demand, tariff 8, register 3

3.2. DEMAND MEASUREMENT MODES

Demand measurement is based on measurement of energy integrated over a demand period $\mathbf{T_{dp}}$ and dividing the energy by the demand period so that average demands are obtained as a result. Momentary values of demands are calculated in a same manner for elapsed time in a current demand period. At the end of each demand period calculated demand is compared with demand in a register of maximum demand for current billing period. If it is larger than the existing maximum demand, it is entered into the register otherwise it is neglected.

The modes of demand measurement differ regarding:

- demand period type
- triggering of demand period start

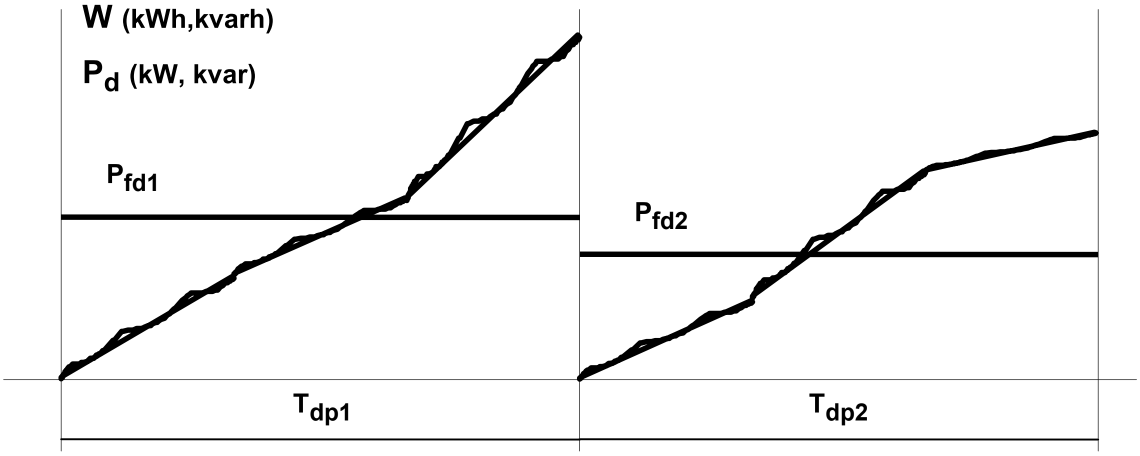
3.2.1. Demand period types

There are two basic demand period types:

- fixed demand period
- rolling demand period

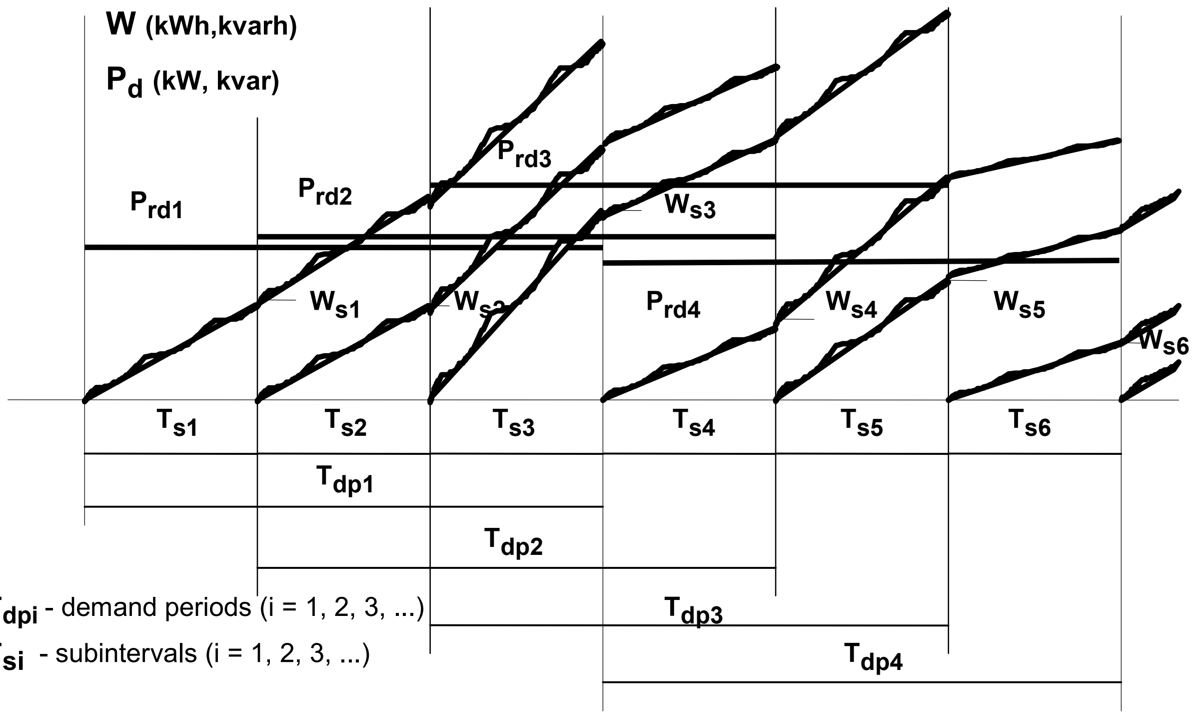
3.2.1.1. Demand measurement in a fixed demand period

At fixed demand measurement a new demand period starts when the previous one is ended.



3.2.1.2. Demand measurement in a rolling demand period

At rolling demand measurement a demand period T_{dp} is divided into subintervals T_S, so that the demand period is a multiple of the subintervals. At the end of each subinterval starts a new demand period.



T_{dpi} - demand periods (i = 1, 2, 3, ...)

T_{si} - subintervals (i = 1, 2, 3, ...)

3.2.1.3. Routines of demand calculation

In case of fixed demand period, demand $\mathbf{P_{fdi}}$ is calculated as a quotient of energy integrated over demand period $\mathbf{T_{dpi}}$ and the demand period, i.e.:

$$P_{fdi} = \frac{W_i}{T_{dpi}}$$

where:
$\mathbf{P_{fdi}}$ - fixed demand in the i-th demand period $\mathbf{T_{dpi}}$ (i = 1, 2, 3, ...)
$\mathbf{W_i}$ - energy integrated over the i-th demand period $\mathbf{T_{dpi}}$ (i = 1, 2, 3, ...)

In case of rolling demand period, demand $\mathbf{P_{rdi}}$ is calculated from the following equation

$$P_{rdi} = \frac{\sum_{i=1}^{i+n-1} W_{si}}{T_{dp}}$$

where:
$\mathbf{P_{rdi}}$ - rolling demand registered in the i-th demand period (i = 1, 2, 3, ...)
$\mathbf{W_{si}}$ - energy integrated over the i-th subinterval (i = 1, 2, 3,...)
n - a number of subintervals in the demand period $\mathbf{T_{dp}}$

3.2.1.4. Setting demand period type

Demand period type is set by defining lengths of a demand period in a register **0.8.0** and a subinterval in a register **0.8.2** both expressed in minutes. If demand in fixed demand period is to be measured, subinterval should be of the same length as the demand period. If demand in rolling demand period is to be measured, length of a subinterval should be chosen so that subintervals are contained in the demand period without a residual and a number of subintervals should not be larger than 15. Both a demand period $\mathbf{T_{dp}}$ and a subinterval $\mathbf{T_s}$ can be set in a range from 1 to 60 minutes, with step of 1 minute.

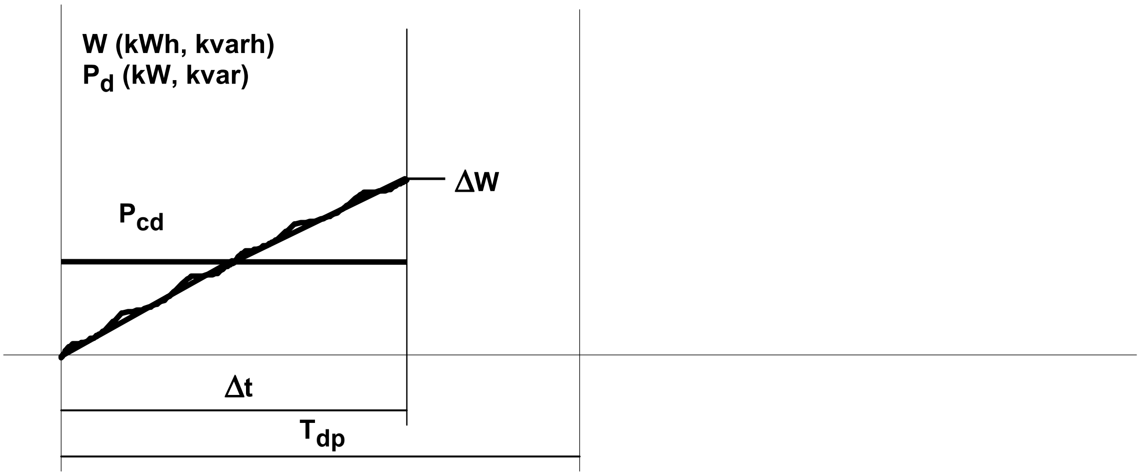
Example
If a rolling demand is to be measured and the demand period is 15-minute, the subinterval length can be 1, 3 or 5 minutes.

Note
If such a length of a subinterval is chosen that a number of subintervals is larger than 15, the meter itself will enter 1 minute both into the register 0.8.0 (demand period) and the register 0.8.2 (subinterval). Consequently fixed demand will be measured.

Example
If a fixed demand is to be measured and the demand period is 15-minute, the subinterval length should be 15 minutes too.

3.2.2. Calculation of momentary values of demands in a current demand period

The real-time clock measures elapsed time in a current demand period. The elapsed time is stored in a register **C.55.0** and can be both displayed on the LCD and transferred via the communication interfaces. The microprocessor calculates momentary values of all demands in a current demand period.



where:
$\mathbf{T_{dp}}$ - demand period
Δt - elapsed time in a current demand period
ΔW - energy integrated over the elapsed time
$\mathbf{P_{cd}}$ - momentary value of demand in the current demand period

The momentary value of demand in a current demand period is calculated according to the following equation:

$$P_{cd} = \frac{\Delta W}{\Delta t}$$

3.2.2.1. Tariff rated momentary values of demands in a current demand period

The TE851 meters enable registration of up to 24 different tariff rated momentary values of demands in a current demand period. Up to 8 different tariff rates can be defined and for each rate 3 registers are available.

EDIS	name of variable	EDIS	Name of variable
1.4.1	3-ph. Mom. demand, tariff 1, reg. 1	1.4.5	3-ph. Mom. demand, tariff 5, reg. 1
5.4.1	3-ph. Mom. demand, tariff 1, reg. 2	5.4.5	3-ph. Mom. demand, tariff 5, reg. 2
8.4.1	3-ph. Mom. demand, tariff 1, reg. 3	8.4.5	3-ph. Mom. demand, tariff 5, reg. 3
1.4.2	3-ph. Mom. demand, tariff 2, reg. 1	1.4.6	3-ph. Mom. demand, tariff 6, reg. 1
5.4.2	3-ph. Mom. demand, tariff 2, reg. 2	5.4.6	3-ph. Mom. demand, tariff 6, reg. 2
8.4.2	3-ph. Mom. demand, tariff 2, reg. 3	8.4.6	3-ph. Mom. demand, tariff 6, reg. 3
1.4.3	3-ph. Mom. demand, tariff 3, reg. 1	1.4.7	3-ph. Mom. demand, tariff 7, reg. 1
5.4.3	3-ph. Mom. demand, tariff 3, reg. 2	5.4.7	3-ph. Mom. demand, tariff 7, reg. 2
8.4.3	3-ph. Mom. demand, tariff 3, reg. 3	8.4.7	3-ph. Mom. demand, tariff 7, reg. 3
1.4.4	3-ph. Mom. demand, tariff 4, reg. 1	1.4.8	3-ph. mom. demand, tariff 8, reg. 1

5.4.4	3-ph. Mom. demand, tariff 4, reg. 2	5.4.8	3-ph. mom. Demand, tariff 8, reg. 2
8.4.4	3-ph. Mom. demand, tariff 4, reg. 3	8.4.8	3-ph. mom. Demand, tariff 8, reg. 3

3.2.2.2. Demands registered in the last ended demand period

All demands that were registered in the last ended demand period are stored in the corresponding registers.

3.2.2.3. Tariff rated demands in the last ended demand period

The TE851 meters enable registration of up to 24 different demands registered in the last ended demand period. Up to 8 different tariff rates can be defined and for each rate 3 registers are available.

EDIS	Name of variable	EDIS	Name of variable
1.5.1	3-phase demand tariff 1, register1	1.5.5	3-phase demand tariff 5, register1
5.5.1	3-phase demand tariff 1, register2	5.5.5	3-phase demand tariff 5, register2
8.5.1	3-phase demand tariff 1, register3	8.5.5	3-phase demand tariff 5, register3
1.5.2	3-phase demand tariff 2, register1	1.5.6	3-phase demand tariff 6, register1
5.5.2	3-phase demand tariff 2, register2	5.5.6	3-phase demand tariff 6, register2
8.5.2	3-phase demand tariff 2, register3	8.5.6	3-phase demand tariff 6, register3
1.5.3	3-phase demand tariff 3, register 1	1.5.7	3-phase demand tariff 7, register1
5.5.3	3-phase demand tariff 3, register 2	5.5.7	3-phase demand tariff 7, register2
8.5.3	3-phase demand tariff 3, register 3	8.5.7	3-phase demand tariff 7, register3
1.5.4	3-phase demand tariff 4, register 1	1.5.8	3-phase demand tariff 8, register1
5.5.4	3-phase demand tariff 4, register 2	5.5.8	3-phase demand tariff 8, register2
8.5.4	3-phase demand tariff 4, register 3	8.5.8	3-phase demand tariff 8, register3

All demands can be both displayed on the LCD and transferred via the communication interfaces.

3.2.3. Demand measurement modes regarding the way of triggering the beginning of the demand period

Demand periods can be either synchronised with day or load profile period and day. This means that a demand period starts at 00:00 hours and that during a day there will be an integer number of demand periods completed. If load profile is measured, then the load profile period is a multiple of demand periods and a demand period starts synchronously with the load profile period. Both the load profile period and demand period are synchronised with a day.

Example
Only demand is measured in the synchronous mode. The demand period is 15 minute. The first demand period in a day starts at 00:00 o'clock, the second one starts at 00:15 o'clock, the third one starts at 00:30 o'clock etc., so that the last demand period in a day starts at 23:45 o'clock.

Note
In the synchronous demand measurement mode the demand measurement can start at any time during a day, but the first demand period may not be complete. For instance, the demand period is 15-minute, and the first demand measurement is started at 10:20. Consequently the first demand period will last only 10 minutes, so that the second demand period will start at 10:30. The second demand period and all demand periods afterwards will last 15 minutes.

Example
A demand is measured and a load profile is registered in the synchronous mode. The load profile is a multiple of the demand period, e.g. the demand period is 15-minute and the load profile period is 60 minute. The first demand period and load profile period in a day starts at 00:00 o'clock every day.

Note
A demand is measured and the load profile is registered in a synchronous mode. The first demand measurement and load profile registration can start at any time during a day, but the first demand period and may not be complete. For instance, the demand period is 15-minute and the load profile period is 60-minute. The first demand measurement and load profile registration are started at 17:38. Consequently the first demand period will last only 7 minutes and the first load profile registration will last 22 minutes. The second demand period will start 17:45, the third one will start at 18:00, etc. The second load profile period will start at 18:00, the third one at 19:00, etc. Both demand period and load profile period are synchronised with a day so that the last demand period in a day will start at 23:45 and the last load profile period will start at 23:00.

In the asynchronous mode both demand period and load profile period start independently of each other. Every demand and load profile period last as it is defined regardless of their start time. The start of the periods is triggered after Watchdog reset, power-up (restoration of power supply after power shortage), time setting and parameter setting.

There are 6 different modes of demand measurement regarding the way of triggering the demand period. They can be selected by a parameter setting in the register **C.59.2**.

Register C.59.2	Measuring mode	Triggering on MPE*
0	Asynchronous - fixed demand period	NO
1	Asynchronous - rolling demand period	NO
2	Synchronous	NO
3	Asynchronous- fixed demand period	YES
4	Asynchronous - rolling demand period	YES
5	Synchronous	YES

***MPE** - input for external starting a demand period

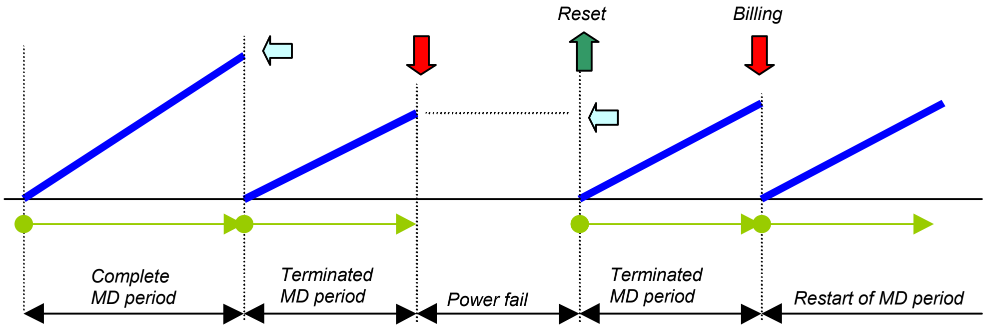
The states of the TE851 meter are indicated with a parameter in the register ID_260.
It has the following values:

Register ID_260	Measuring mode
0	Asynchronous mode - fixed demand period
1	Asynchronous mode - rolling demand period
2	Synchronous mode
3	Demand measurement is started with an external signal MPE

3.2.3.1. Fixed demand measurement in the asynchronous mode

The demand period runs asynchronously and is started at a rest (at the end of billing period or tariff changeover). The demand period time is defined as a parameter stored in the registers **0.8.0** (demand period) and **0.8.2** (subinterval). The demand period can be set in a range from 1 to 60 minutes, in steps of one minute. The start and length of demand period under different circumstances are shown in the figure bellow.

The demand period is started at: POWER-UP (restoration of power supply after power shortage), after WATCH DOG reset, after parameter setting and after setting the time. The end of a billing period and tariff changeover may or may not interrupt the demand period.



Pushbuttons:

The course of demand period. The percentage of elapsed time in the demand period is stored in the register **C.55.0** and is displayed on the LCD or can be transferred via the communication interfaces.

Power Down (power shortage)

Reset occurs at: Power Up (restoration of power supply after power shortage), Watch Dog reset, after parameter setting and after time setting.

3.2.3.2. Rolling demand measurement in the asynchronous mode

In asynchronous mode the demand period starts at reset, at the end of a billing period or tariff changeover. The rolling demand measurement is defined by demand period $\mathbf{T_{dp}}$ set in the register **0.8.0** and subinterval $\mathbf{T_{s}}$ set in the register **0.8.2**. Lengths of demand period and subinterval can be set in a range from 1 to 60 minutes, with a step of 1 minute.

Note
The demand period should be a multiple of the subinterval. Maximum 15 subintervals are allowed, otherwise both demand period and subintervals are set to 1 minute automatically (see item 3.2.1.2). Consequently fixed demand will be measured.

A routine of the rolling demand calculation in the microprocessor is performed in such a way that energy is integrated over a subinterval. At its end the subinterval counter is incremented by 1 (i=1) and energy integration over the next subinterval starts. At the end of the second subinterval the integrated energy is summed up with the energy integrated in the first subinterval and the subinterval counter is incremented by 1 (i=2). The routine is repeated again. When a number in the subinterval counter is **i=n** (n is a number of subintervals in the demand period) the first demand is calculated as

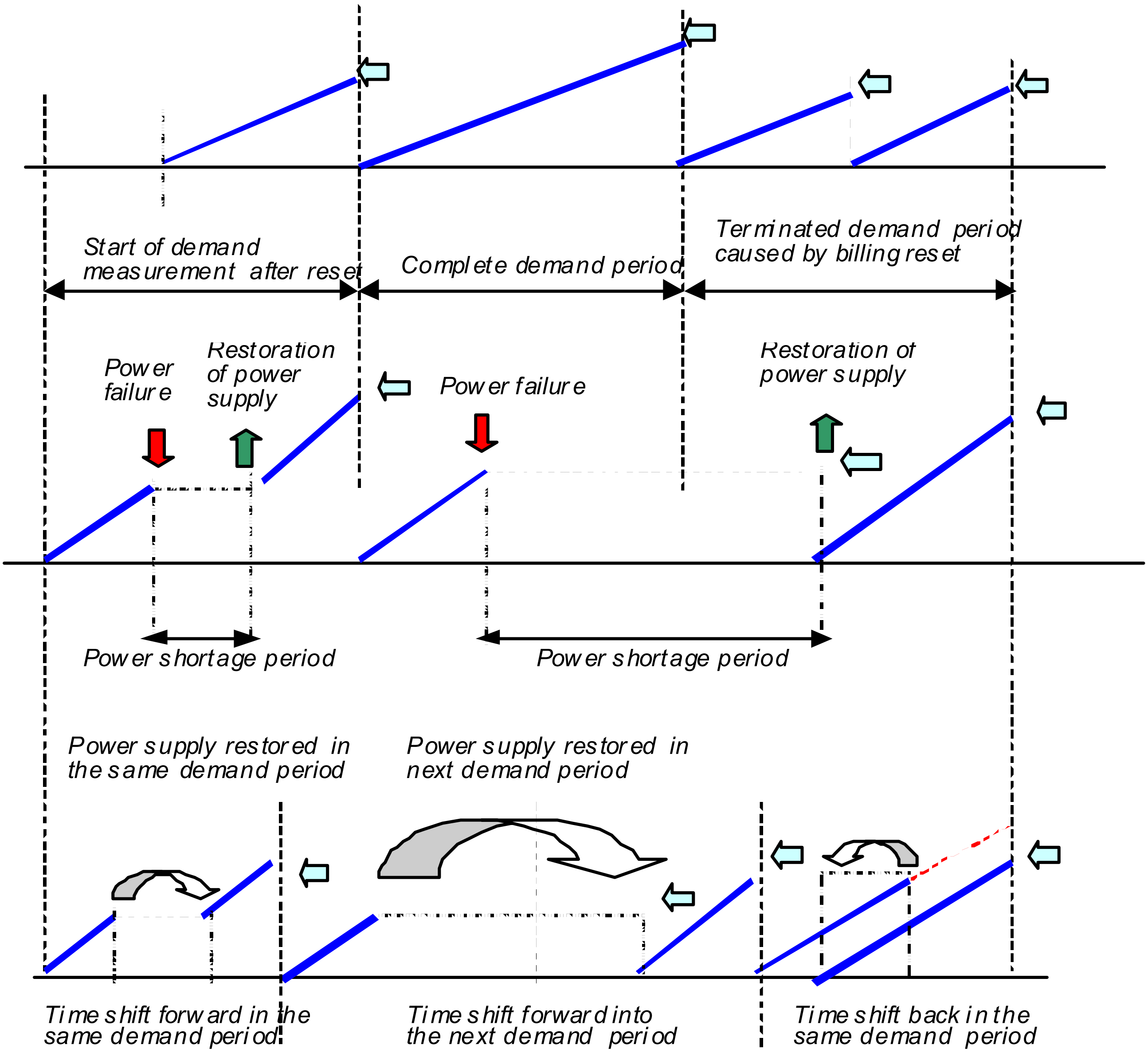
Demand = (sum of energies integrated over n of subintervals) / demand period

The subinterval counter is incremented again by 1 (i=n+1) and the energy integrated over the (i-n)-th subinterval is subtracted from the energy sum. At the end of the subinterval energy integrated over the n+1 subinterval is added to the sum, the second demand is calculated, the energy integrated over the (i-n)-th subinterval is subtracted from the sum and the subinterval counter is incremented. The routine is repeated again and again.

3.2.3.3. Fixed demand measurement in the synchronous mode

The demand period $\mathbf{T_{dp}}$ should be set both in the register **0.8.0** (demand period) and **0.8.2** (subinterval). The demand period has to be contained in a day without a residual. The first demand period in a day starts at 00:00 (see item 3.2.3).
The demand measurement in a synchronous mode differs from the demand measurement in asynchronous mode in cases when the demand period is interrupted due to power shortage. The main difference is that the demand measurements continue if the power supply is restored in the same demand period; otherwise it is ended for that demand period and the demand measurement is started again at the point of a new demand period when the power supply is restored.

The following events cause demand period interruption: power shortage, time setting, parameter setting, billing reset, watchdog reset, etc.



The percentage of elapsed time of demand period indicates how much time has elapsed till the moment when the demand measurement was started (e.g. the power supply has been restored in the middle of a new demand period, therefore the elapsed time percentage in the register **C.55.0** will be 50).

3.2.3.4. Triggering of demand period with an external signal on the MPE input

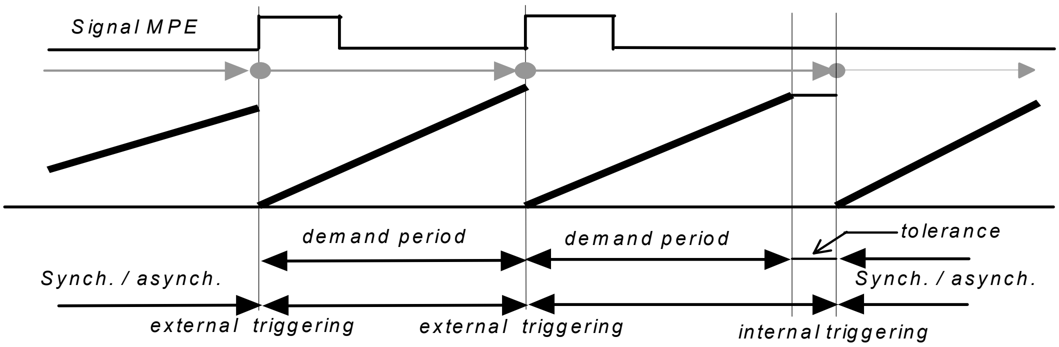
The external triggering of demand period is enabled when a parameter in the register **C.59.2** has value 3, 4 or 5. The demand period starts on the rising edge of a control signal on the MPE input. When a parameter in the register **C.59.2** has value 0, 1 or 2 the MPE input is disabled, therefore a control signal on it does not start a demand period. In this case the MPE input can be used only for synchronisation of the real-time clock.

In order to start demand measurements with external pulses on the MPE input the following parameters should be set:

a. demand period should be set in the register **0.8.0**
b. subinterval should be set in the register **0.8.2** (in case of fixed demand measurement this value is equal to the demand period)
c. mode of demand measurement should be defined by setting the following value in the register **C.59.2**:
   3 - asynchronous with fixed demand period (triggered by control pulses on the MPE)
   4 - asynchronous with rolling demand period (triggered by control pulses on the MPE)
   5 - synchronous demand measurement (triggered by control pulses on the MPE)
d. time span (expressed in seconds) within which a control pulse should appear at the MPE input after the end of the previous demand period. This parameter should be entered into the register **C.55.11**

When the demand period is started with a control signal on the MPE input, demand is calculated by dividing energy integrated over a time between two successive control pulses with the demand period set in the register **0.8.0** (even if the time between the two pulses is shorter than the demand period). If the next pulse does not appear on the MPE input within the time span defined in the register **C.55.11** after the end of the previous demand period, this is considered that the external triggering of demand period has failed and the meter automatically turn on the corresponding mode of demand measurement with internal triggering of demand periods.

Note
When time between two successive control pulses at the MPE input is longer than the set demand period in the register 0.8.0, energy is integrated over the set demand period only. The demand is not measured from the demand period end till the next pulse appearance on the MPE input (see detail A in the figure bellow).



3.2.4. Modes of maximum demand measurement regarding a billing reset and tariff changeover

Neither a billing reset (at the end of a billing period) and demand period nor tariff changeover and demand period are synchronised. This means that in most cases a billing reset and/or tariff change - over are performed during a current demand period and not at its end. On the other hand both billing reset and tariff changeover start demand measurement in a new demand period. Due to this fact, the following maximum demand measurement modes regarding a billing reset and tariff changeover are possible:

- both billing reset and tariff changeover interrupts the current demand period
- billing reset does not interrupt the demand period but tariff changeover does
- billing reset is delayed up to the end of the demand period, tariff changeover interrupts the demand period
- billing reset does not interrupt the demand period, tariff changeover is delayed up to the end of the demand period
- both billing reset and tariff changeover are delayed up to the end of the current demand period

The TE851 meters enable a customer to define how tariff changeover and billing resets will affect demand measurement. This can be done by setting a corresponding parameter in the register **C.59.4**, as it is shown in the table bellow.

Value	Influence of billing reset	Influence of tariff changeover
0	Billing reset interrupts the demand period	Tariff changeover interrupts the demand period
1	Billing reset does not interrupt the demand period	Tariff changeover interrupts the demand period
2	Billing reset is delayed up to the end of the demand period	Tariff changeover interrupts the demand period
3	Billing reset interrupts the demand period	Delayed tariff changeover up to the end of the demand period
4	Billing reset does not interrupt the demand period	Delayed tariff changeover up to the end of the demand period
5	Billing reset is delayed up to the end of the demand period	Delayed tariff changeover up to the end of the demand period

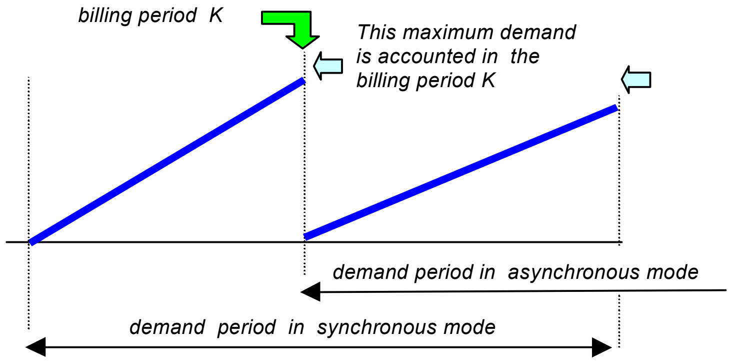
3.2.4.1. Modes of maximum demand measurement regarding billing reset

The following maximum demand measurement modes regarding billing reset are possible:

- billing reset interrupts the current demand period
- billing reset does not interrupt the current demand period
- execution of billing reset is delayed up to the end of the current demand period

3.2.4.1.1. Billing reset interrupts the current demand period

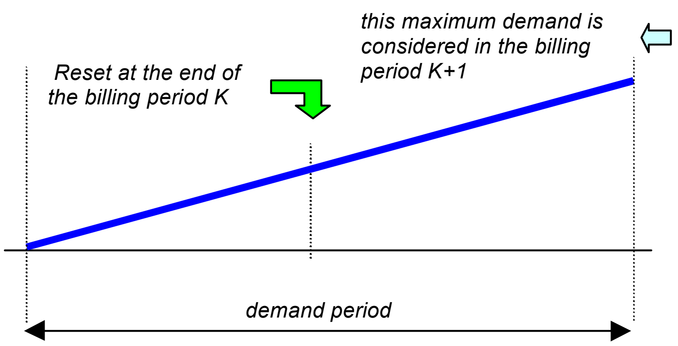
Billing reset (at the end of a billing period) is executed during a current demand period and interrupts it. Demand of interrupted period is considered in the just ended billing period. If the demand exceeds the maximum demand of the just ended billing period, it will be considered as a maximum demand of that billing period (billing period K in the figure bellow).



After the billing reset, the demand registers of a current billing period are cleared and measurement of maximum demand for a new billing period is started.

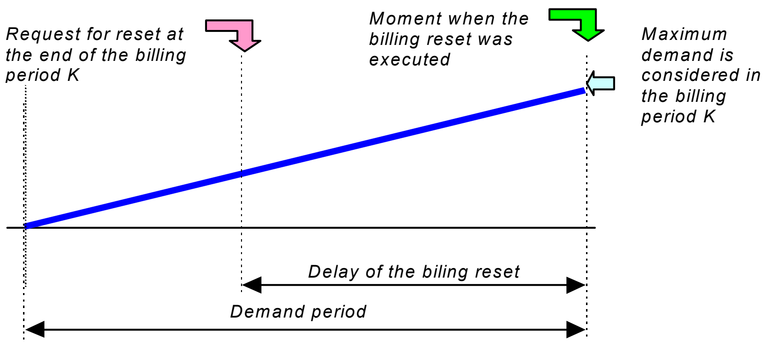
3.2.4.1.2. Billing reset does not interrupt the current demand period

Billing reset (at the end of a billing period) is performed during a current demand period but does not interrupt it. Demand registered in the demand period in which the billing reset was performed is considered in the next billing period although a part of energy was integrated in just ended billing period. If it will be the largest demand in the new billing period, it will be registered as its maximum demand (billing period K+1 in the figure bellow).



3.2.4.1.3. Execution of billing reset is delayed up to the end of the current demand period

In this mode the microprocessor does not execute a command for a billing reset immediately. Instead of that it delays the billing reset up to the end of the current demand period. Consequently the current demand period is not interrupted and the billing period is extended up to its end. The demand of demand period in which the billing reset was requested is considered in the extended billing period. If the demand is the largest one in the extended billing period, it is registered as the maximum demand (billing period K in the figure bellow).



Note that as the end of the billing period are registered the time and date at the moment when the billing reset was requested and not when it was actually performed.

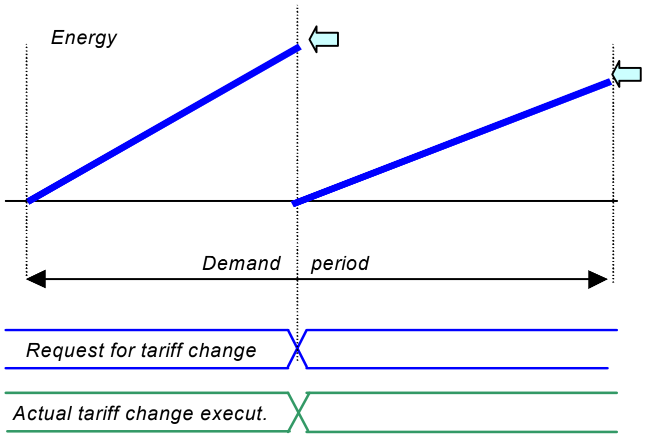
3.2.4.2. Modes of maximum demand measurement regarding tariff changeover

The following maximum demand measurement modes regarding a time of tariff changeover are possible:

- tariff changeover interrupts the current demand period
- execution of tariff changeover is delayed up to the end of the current demand period

3.2.4.2.1. Tariff changeover interrupts the current demand period

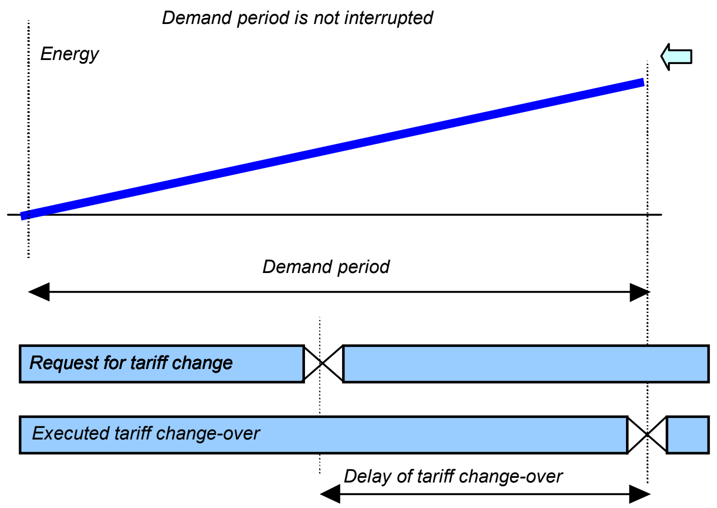
Tariff changeover is executed during the current demand period and interrupts it.



The microprocessor changeover the tariff at the moment when it was requested. Consequently the current demand period is interrupted at the moment of tariff changeover and demand measurement is started in a new demand period. If demand in the interrupted demand period is the largest one in the billing period, it is considered as the maximum demand and is accompanied with time and date of the tariff changeover (actual the end of the corresponding demand period).

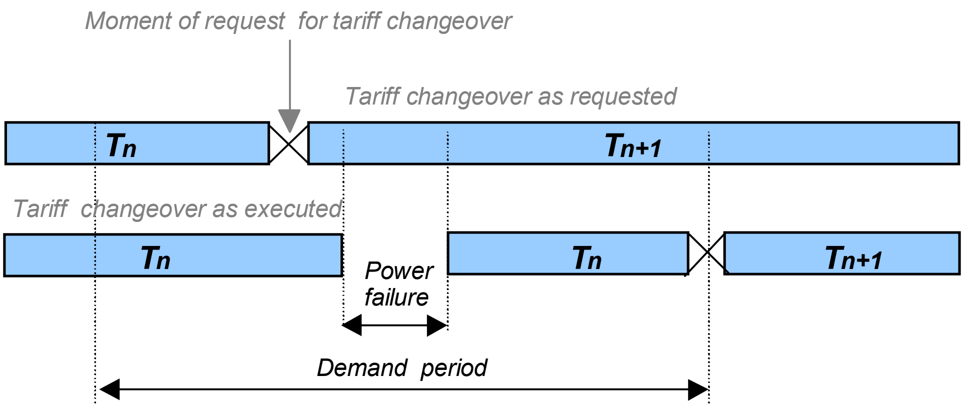
3.2.4.2.2. Execution of tariff changeover is delayed up to the end of the current demand period

Execution of tariff changeover is delayed up to the end of the current demand period.



In this mode the microprocessor does not execute a command for tariff changeover immediately. Instead of that it delays the tariff changeover command up to the end of the current demand period. Consequently the current demand period is not interrupted.

A special case in the synchronous mode with delayed tariff changeover is when either a command for reset (e.g. billing reset, watchdog reset) was received or a power shortage was appeared when the tariff was changing-over (see figure bellow).



During a current demand period a command for changing-over tariff from T_n to T_{n+1} was received. Power failure occurred after that. As both data on valid tariff and requested tariff change-over command are stored in a non-volatile memory, the tariff valid before the power shortage (T_n) will be valid till the end of the first demand period after the power supply restoration. At its end the tariff will be changed-over to the requested tariff (T_{n+1}). This will happen regardless if the tariff changeover is controlled by the internal real-time clock or an external time-switch, ripple control receiver or other tariff controlling device.

3.2.5. Forgiveness period for demand measurement

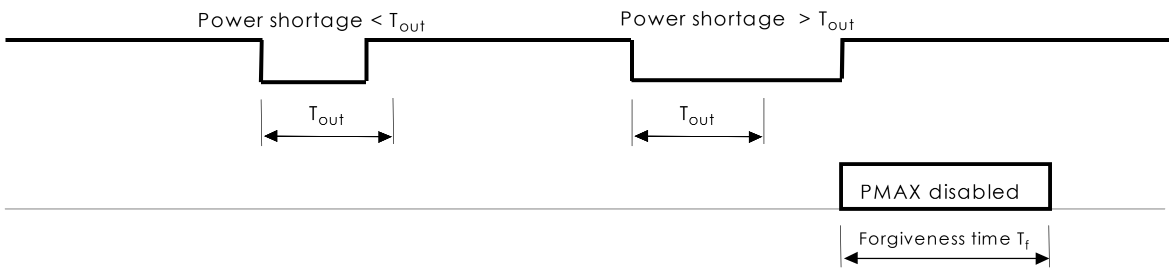
Electric utilities can forgive their customers to measure maximum demand for a time span $\mathbf{T_f}$ in case of power shortage that lasted longer than a certain time $\mathbf{T_{out}}$. This means that electric utility allows to its customers to exceed the contractual maximum demand for some time after power shortage without paying penalty. A period without demand measurement is called forgiveness period.
Forgiveness period is an optional function that is enabled by the TE851 meters. It can be controlled either by the internal real-time clock or externally by applying control voltage to the input MZE.

The forgiveness period function should be requested and specified by ordering the meters.

It should be stated a version of the forgiveness period control (internal or external). In case of the internal forgiveness period control it should be also specified duration of power shortage $\mathbf{T_{out}}$ after which the forgiveness period will be allowed and length of the forgiveness period $\mathbf{T_f}$, both expressed in minutes. In case of an external forgiveness period control it should be specified at which auxiliary terminal has to be the MZE input.

3.2.5.1. Forgiveness period controlled by the internal RTC

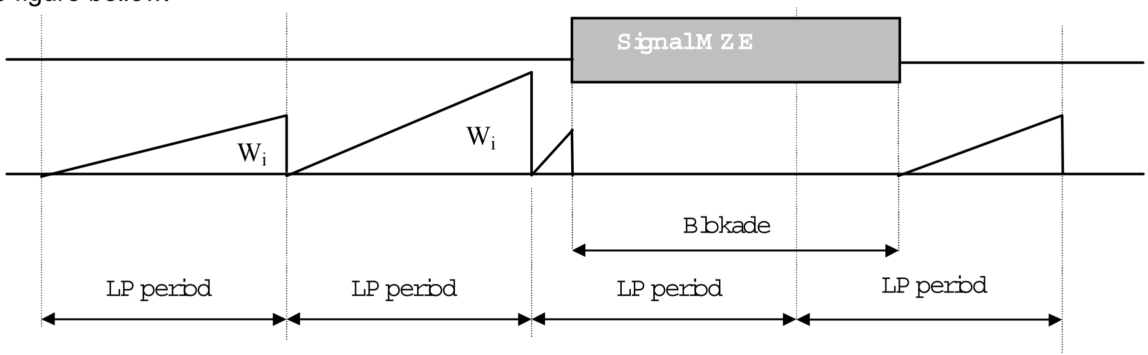
If the forgiveness period is controlled by the internal real-time clock, the length of the forgiveness period $\mathbf{T_f}$ is stored in the register **C.55.7**; duration of power shortage $\mathbf{T_{out}}$ (after which the forgiveness function is activated) is stored in the register **C.55.8**. Both values are expressed in minutes. An example of the internal control of forgiveness period is shown in the figure bellow.



Example:The first power failure is shorter than T_{out}, therefore demand measurement is not disabled. The second power failure is longer than T_{out}, therefore demand measurement is disabled. The demand is measured again when time T_f elapses.

3.2.5.2. Forgiveness period controlled by an external signal

The TE851 meters can be provided with the MZE input for external disabling of demand measurement. Line-to-neutral voltage is applied to the MZE input during the forgiveness period to disable demand measurement; when there is no voltage applied, demand measurement is enabled.
An example of external control of forgiveness period applied to the load profile registration is shown in the figure bellow.



4. DETECTION OF THE PRESENCE OF PHASE VOLTAGES

The TE851 meters detect and optionaly alarm of phase voltage failure. In such case the phase voltage failure counter of the corresponding phase is incremented by 1. There are 3 phase voltage failure counters, one for each phase. They count phase voltage failures in a range from 0 to 65,535.

The phase voltage failure can be indicated on the LCD and transferred via the communication interfaces. The presence of phase voltages and direction can be read as parameters **N_184** and **N_355**.

LCD

EDIS code	Quantity name
C.7.1	Number of phase voltage failures, phase L1
C.7.2	Number of phase voltage failures, phase L2
C.7.3	Number of phase voltage failures, phase L3
N_184	Presence of phase voltages
N_355	Directions

Communication

Type	ID	Format	Response	Description	
R1	N_184	Ime	(data) ⇒ type T_CHAR	Presence of phase voltages: bit 2 = 1/0 Þ phase L1 voltage yes/no bit 1 = 1/0 Þ phase L2 voltage yes/no bit 0 = 1/0 Þ phase L3 voltage yes/no	
R1	N_355	Ime	(data) ⇒ type T_CHAR	Direction: bit 7, 6 - common bit 5, 4 - Phase L1 bit 3, 2 - Phase L2 bit 1, 0 - Phase L3	bit(n+1) bit(n) quadrant D A quadrant 0 0 3 0 1 4 1 0 2 1 1 1

5. MULTIRATE REVENUE METERING

The TE851 meters enable multiple rate registration of energy and demand (see item 5.1.). Different tariff changeover schedules can be defined for energy and demand. On the other hand, several tariffs can be valid at the same time. These enable flexible and complex tariff systems for energy and demand to be programmed.

The tariff changeover can be simultaneously controlled by several tariff control sources which have different or same priorities (see item 5.2). Tariff changeover is performed by tariff control source that has the highest priority, therefore priority of individual sources should be specified by ordering. In case of tariff control sources of the same priority they define valid tariffs.

5.1. NUMBER OF TARIFF REGISTERS

A number of tariff rates is up to 8 both for energy and demand. Valid tariffs for energy and demands are indicated by flags set in bytes stored in the registers **N_182** and **N_183** respectively.

Register N_182: Flags of valid tariff for energy

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
1	1	1	1	1	1	1	1
Tariff 8	Tariff 7	Tariff 6	Tariff 5	Tariff 4	Tariff 3	Tariff 2	Tariff 1

Register N_183: Flags of valid tariff for demand

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
1	1	1	1	1	1	1	1
Tariff 8	Tariff 7	Tariff 6	Tariff 5	Tariff 4	Tariff 3	Tariff 2	Tariff 1

Each tariff can have up to 3 simultaneously operating tariff registers. Therefore total 24 registers for energy and 24 registers for demand are available for multirate registration of different energies and demands. These registers enable a customer to program different combinations of multirate registration different energies and demands, e.g.:

- 3 energies (+A, R1 and R4) and 3 demands (+P, Q1 and Q4) in 8 tariffs
- 4 energies (+A, -A, Rp=R1+R2 and Rn=R3+R4) and 4 demands (+P, -P, Qp=Q1+Q2 and Qn=Q3+Q4) in 6 tariffs
- full 4-quadrant measurement (energies: +A, -A, R1, R2, R3 and R4 as well as demands: +P, -P, Q1, Q2, Q3 and Q4) in 4 rates

Note
At meter order the customer should specify a number of tariffs NT (maximum 8) and a number of parallel registers per tariff NR (maximum 3). Specified numbers are valid both for a number of energy registers and demand registers.

Example
A meter with a number of tariffs NT = 8 and a number of parallel registers per tariff NR = 3, i.e. with 24 tariff registers, can be used as:

- *A meter which registers 3 demands and energies in eight tariffs:*
demands +P, Q1 and Q4;

Tariff 1	Tariff 2	Tariff 3	Tariff 4	Tariff 5	Tariff 6	Tariff 7	Tariff 8
+P	+P	+P	+P	+P	+P	+P	+P
Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4

and energies +A, R1, R2.

Tariff 1	Tariff 2	Tariff 3	Tariff 4	Tariff 5	Tariff 6	Tariff 7	Tariff 8
+A	+A	+A	+A	+A	+A	+A	+A
R1	R1	R1	R1	R1	R1	R1	R1
R4	R4	R4	R4	R4	R4	R4	R4

- *A complete 4-quadrant meter for 4-rate registration:*
demands +P,-P, Q1, Q2, Q3 and Q4;

Tariff 1	Tariff 2	Tariff 3	Tariff 4
+P	+P	+P	+P
Q1	Q1	Q1	Q1
Q4	Q4	Q4	Q4
Tariff 5	**Tariff 6**	**Tariff 7**	**Tariff 8**
-P	-P	-P	-P
Q2	Q2	Q2	Q2
Q3	Q3	Q3	Q3

and energies +A, -A, R1, R2, R3, R4.

Tariff 1	Tariff 2	Tariff 3	Tariff 4
+A	+A	+A	+A
R1	R1	R1	R1
R4	R4	R4	R4
Tariff 5	**Tariff 6**	**Tariff 7**	**Tariff 8**
-A	-A	-A	-A
R2	R2	R2	R2
R3	R3	R3	R3

Note that tariff 5 corresponds to tariff 1, tariff 6 corresponds to tariff 2, tariff 7 corresponds to tariff 3 and tariff 8 corresponds to tariff 4. Therefore tariff couples T1/T5, T2/T6, T3/T7 and T4/T8 are changed-over at the same time so that all six energies and demands have the same tariff changeover schedule.

5.2. TARIFF CONTROL SOURCES

Tariff changeover can be controlled by:

- internal tariff device
- externally via tariff inputs
- externally via communication interfaces
- by internal ripple control receiver (not implemented yet)

The TE851 meters enable simultaneously tariff changeover by tariff control sources that have different or same priorities. The priorities of tariff control sources should be defined during the meter configuration. These neither can be done nor can be changed subsequently by a customer.

Note
Tariff control sources and their priority are to be specified at meter ordering.

The tariff changeover that is required by a tariff control source with a higher priority is valid. In case of four tariff control sources with different priorities the one with the highest priority has priority 1 and the one with the lowest priority has value 4. When the first priority tariff control source fails, the tariff control source with the next lower priority controls the tariff automatically. In case of tariff control sources of same priority, valid tariffs at same time defined by them.

Note
If the internal tariff device has the highest priority, it will control the tariff changeover, except if it fails. Consequently the electric utility will have no possibility to change a tariff remotely in case of need as long as the internal tariff device function properly.

Example
A customer has specified the following tariff control sources and their priorities by his order:

Tariff control source	Priority
Internal tariff device	3
Tariff inputs	1
Internal ripple control receiver*	2
Communication interface	2

** Hypothetically as a meter with an internal ripple control receiver is not available yet*

If there is a voltage on the tariff inputs, a tariff is valid defined by them regardless of commands received by the internal ripple control receiver and/or communication interface as well as regardless of time and programmed tariff changeover schedule in the internal tariff device.

If there is no voltage applied to the tariff inputs, the tariff(s) is (are) valid received by the internal ripple control receiver and/or a communication interface, regardless of time and programmed tariff changeover schedule in the internal tariff device.

If there is no voltage applied to the tariff inputs, and there is no commands for tariff changeover received by the internal ripple control receiver and/or a communication interface, the tariff will be controlled by the internal tariff device, depending on time and programmed tariff changeover schedule.

The tariff changeover source which controls tariff at the moment is indicated by a flag set in a byte in the register **N_471**. This register is accessible via communication interfaces.

bit 7	bit 6	Bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
1	1	0	1	1	1	0	1
Energy tariff program	Tariff input for energy	not used*	Commun. interface energy	Demand tariff program	Tariff input for demand	not used**	Commun. interface demand

1* The flag is reserved for tariff control of energy by the internal ripple control receiver.
2** The flag is reserved for tariff control of demand by the internal ripple control receiver.

5.2.1. Tariff device

The tariff device is based on an internal real-time clock (RTC) which is controlled by a quartz crystal (see chapter 14) and tariff changeover schedules programmed separately for energy and demand.

5.2.1.1. Tariff changeover programs

Tariff changeover programs for energy and demand are independent and are programmed separately. The tariff changeover program is defined with the following data:

- daily programs
- weekly programs
- seasons

Note
A requested number of daily programs NDP¸ weekly programs NTP and seasons NSE should be specified at meter ordering. Numbers of daily and weekly program as well as a number of seasons valid both for energy and demand.

Actual operation of the internal tariff device is determined by parameter setting. Parameters can be set for annual schedule, weekly schedules and daily schedules. The tariff program for energy and demand can be either the same or different.

5.2.1.1.1. DAILY PROGRAMS

Daily programs define daily schedules of tariff changeover. Up to 64 different daily programs for tariff changeover can be programmed. Daily programs for energy are independent from daily programs for demand.

A daily program consists of time spans in which certain tariff or their combination is valid. Each time span is defined with time of its start which is written in a data format hh:mm, i.e. it is defined by hours and minutes. The first time span in daily programs is always started at 00:00. Up to 32 time spans in a day can be programmed.

Example
Daily program of tariff change-over for energy is given in the table bellow.

Time	***Valid tariff(s)***
00:00	*1*
06:00	*2, 7*
09:15	*3*
11:30	*5, 7*
15:45	*3*
18:30	*6, 7*
21:00	*1*

Time spans of daily programs for energy and demands are defined in the registers **N_124** and **N_129** respectively. Flags of corresponding valid tariff(s) in each time span for energy and demand are stored in the registers **N_125** and **N_130** respectively.

5.2.1.1.2. WEEKLY PROGRAMS

Weekly programs define which daily programs will be active on each day in a week. Up to 64 weekly programs can be programmed. In a weekly program 8 different day types can be defined: 7 for days in a week plus 1 for holidays.

Example
Weekly program for energy is given bellow.

Day	*Number of a daily program*
SUNDAY	*7*
MONDAY	*2*
TUESDAY	*2*
WEDNESDAY	*2*
THURSDAY	*2*
FRIDAY	*2*
SATURDAY	*5*
HOLIDAY	*19*

Weekly programs for energy and demands are defined in registers **N_123** and **N_128** respectively.

5.2.1.1.3. SEASONS

A year can be divided into **seasons** during which one of the programmed weekly program is active. Up to 64 seasons a year can be programmed. Seasons are defined with a date (MMDD, i.e. month and day) and time (hhmm, i.e. hour and minute) of their end and with a corresponding weekly program. The first season starts on 1st of January at 00:00 and is valid till the first defined season end, when the second season starts. The last season is terminated at the end of the year (31st of December at 24:00).

Example
Annual season schedule is given in the table bellow

Season	*Start of a season*	*Programmed end of the season*	*Active weekly program*
1	*1 - 1 - XXXX at 00:00*	*03011200*	*2*
2	*3 - 1 - XXXX at 12:00*	*05150000*	*4*
3	*5 - 15 - XXXX at 00:00*	*10010000*	*3*
4	*10 - 1 - XXXX at 00:00*	*11200230*	*1*
5	*11 - 20 - XXXX at 02:30*	*12312400*	*2*

where XXXX is a year.

Seasons for energy and demands are defined in registers **N_121** and **N_126** respectively.

5.2.1.2. CALENDAR

The annual real-time clock enables definition of calendar, i.e. days in a week as well as dates by the year 2099. It involves the lunar calendar for this period. Therefore setting of holidays based on the lunar calendar is simplified. It also enables daylight saving period.

5.2.1.2.1. HOLIDAYS

Up to 330 holidays per year can be programmed using the following algorithms:

- unique holiday
- every year on MMDD (month and day) date
- every year on the 1st Sunday after the MMDD date
- every year on the 1st Monday after the MMDD date
- every year on the 1st Tuesday after the MMDD date
- every year on the 1st Wednesday after the MMDD date
- every year on the 1st Thursday after the MMDD date
- every year on the 1st Friday after the MMDD date
- every year on the 1st Saturday after the MMDD date
- every year on MMDD date but not on Sunday (it is transferred to Monday)
- a shift forward regarding the Easter day
- a shift backward regarding the Easter day

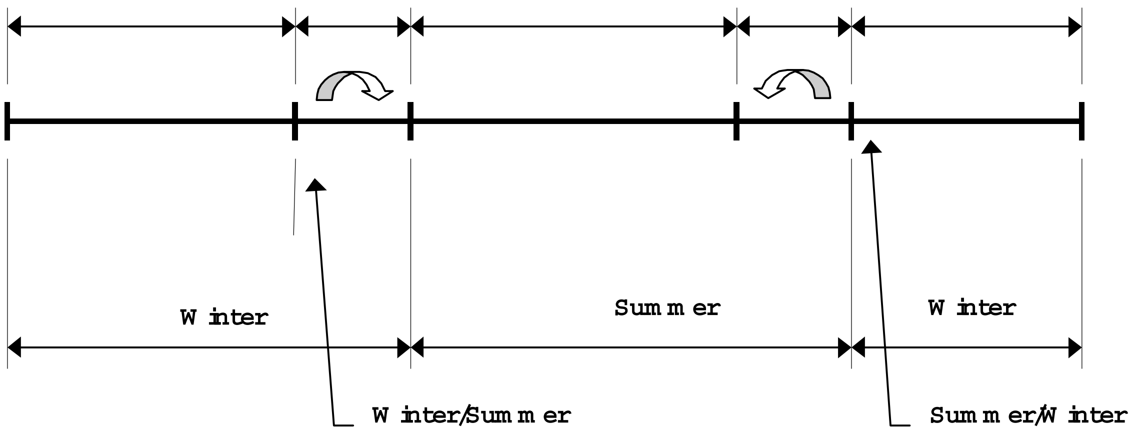
A table containing holidays is stored in a register **N_120**.

5.2.1.2.2. Daylight saving PERIOD

The annual clock enables automatic changing to daylight saving period and back to the standard time, also known as a summer and winter time. The daylight saving period is defined with its beginning and end. They are stored in a form of a table consisting of 8 bytes (4 bytes for the beginning and 4 bytes for the end of the daylight saving period) in the register **N_249.**

Example
Change from a winter to a summer time: the last Sunday in March at 2:00
Change from a summer to a winter time : the last Sunday in October at 3:00

Schematic diagram of changing time due to day-light saving period



In case of power shortage when transition from a winter to a summer time or vice versa is to be performed, the TE851 meter will correct the time automatically when the power supply is restored.

Daylight saving period is indicated with value 1 in the register **0.9.5**, otherwise the value is 0.

5.2.2. Tariff control via tariff inputs

The TE851 meters enable external tariff changeover by applying line-to-neutral voltage to corresponding tariff inputs for energy and for demand. Maximum number of tariff inputs is 6, 3 inputs for energy tariffs (T1, T2 and T3) and 3 inputs for demand tariffs (M1, M2 and M3). With a set of three inputs it is possible to control up to 8 tariffs.

If only 4 tariffs are required, the meters are equipped with 4 tariff inputs, 2 for energy tariffs and 2 for demand tariffs.

If several tariffs are to be valid at the same time, a suitable combination of tariff inputs should be done. In this case it is not necessary to have 2x3 tariff inputs for control energy and demand tariffs of an eight-tariff meter.

Example

Status at inputs	***Valid tariffs***
T1=0, T2=0	*1, 5*
T1=1, T2=0	*2, 6*
T1=0, T2=1	*3, 7*
T1=1, T2=1	*4, 8*

5.2.3. Tariff control via communication interface

Tariffs can be controlled also via a corresponding communication interface (e.g. RS232, CS 20mA) through which the meter is permanently connected to a data logger that can be used for tariff changeover.

Tariffs are controlled by means of parameters stored in a register **N_469** for energy tariffs and in a register **N_470** for demand tariffs. The parameters are bytes in which each bit defines if corresponding tariff is valid (value 1) or not (value 0).

- bit 0 value 0/1 ⇒ tariff 1 inactive/active
- bit 1 value 0/1 ⇒ tariff 2 inactive/active

...
- bit 7 value 0/1 ⇒ tariff 8 inactive/active

The parameters are stored as a vital data in the meter memory. Therefore they are restored after a power shortage.

5.3. BLOCK-TARIFFS

The TE851 meters can be equipped with up to three registers for block-tariffs besides with registers for Time-Of-Use registration. Energy is registered in the registers for block-tariff when demand exceeds the contractual demand. Energy in the block-tariff registers is charged at different price as penalty for exceeding the contractual demand. Limit demand values should be set in the register **N_451** for each block-tariff.

Note
A requested number of block-tariffs (maximum 3) as well as the limit values of demands should be specified at meter ordering.

6. BILLING RESET

A billing period is a period over which energy is integrated and in which maximum demand is calculated with a purpose to charge consumed energy to the consumer. At the end of a billing period the billing reset (**RR**) is performed in order to:

- transfer metering data from registers for a current billing period into the corresponding registers of a previous billing period
- transfer data from registers for previous billing periods into corresponding registers for one billing period back
- to clear registers of demands in a current demand period
- to clear registers of maximum demands
- sum up maximum demands of the just ended billing period with corresponding values in the cumulative demand registers
- generate and register data on origin and status of billing

Registers for storing metering data of 15 previous billing periods are provided in the TE851 meters. On request the meter can store metering data of up to 50 previous billing periods.

The TE851 meters are provided with two counters for previous billing periods. A counter in the register **0.1.0** counts how many billing resets have been performed. This counter increments with each billing reset. A counter in the register **0.1.1** indicates a number of billing periods for which metering data are available in the meter. This counter increments with each billing reset till it reach a number of previous billing periods provided in the meter and than keeps that value.

6.1. TYPES OF BILLING RESETS

The following billing resets can be executed:

- Automatically by the internal tariff device
- Manually by pressing the Reset pushbutton on the meter
- Via communication interfaces
- Via remote reset inputs

6.1.1. Billing reset performed with the internal tariff device

In this case billing reset is performed automatically with the internal real-time clock. A variety of billing reset can be programmed with a software MeterView regarding how often and when it to be performed. The following billing reset options are available:

1.	type = 0	unique date	YY-MM-DD hh:mm
2.	type = 1	every year on the same month and day	MM-DD hh:mm
3.	type = 2	every year on the 1st Monday after the date	MM-DD hh:mm
4.	type = 3	every year on the 1st Tuesday after the date	MM-DD hh:mm
5.	type = 4	every year on the 1st Wednesday after the date	MM-DD hh:mm
6.	type = 5	every year on the 1st Thursday after the date	MM-DD hh:mm
7.	type = 6	every year on the 1st Friday after the date	MM-DD hh:mm
8.	type = 7	every year on the 1st Saturday after the date	MM-DD hh:mm
9.	type = 8	every year on the 1st Sunday after the date	MM-DD hh:mm
10.	type = 9	every year not on Sunday, transfer to Monday	MM-DD hh:mm
11.	type = 10	once a month on a date	DD hh:mm
12.	type = 11	every month on 1st Monday after the day	DD hh:mm
13.	type = 12	every month on 1st Tuesday after the day	DD hh:mm
14.	type = 13	every month on 1st Wednesday after the day	DD hh:mm
15.	type = 14	every month on 1st Thursday after the day	DD hh:mm
16.	type = 15	every month on 1st Friday after the day	DD hh:mm
17.	type = 16	every month on 1st Saturday after the day	DD hh:mm
18.	type = 17	every month on 1st Sunday after the day	DD hh:mm
19.	type = 18	every day	hh:mm
20.	type = 18	every Monday	hh:mm
21.	type = 18	every Tuesday	hh:mm
22.	type = 18	every Wednesday	hh:mm
23.	type = 18	every Thursday	hh:mm
24.	type = 18	every Friday	hh:mm
25.	type = 18	every Saturday	hh:mm
26.	type = 18	every Sunday	hh:mm

Up to 20 billing dates can be entered. On a special request this number can be increased.

6.1.2. Manual billing reset

The manual billing reset can be performed by pressing the Reset pushbutton at any time if the meter is in the Automatic data displaying mode (see item 9.1.7).

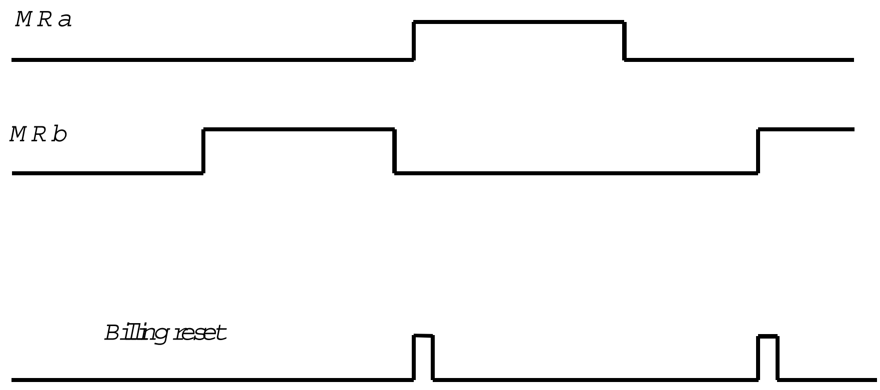
Note
The manual billing reset is disabled when the meter communicates via a communication interface.

6.1.3. Billing reset via a communication interface

Billing reset can be performed via a communication interface by means of a hand-held terminal or a PC. It can be performed via an IR optical interface, CS 20-mA interface or RS232 interface.

6.1.4. Remote billing reset via MRa and MRb inputs

The TE851 meters can be equipped with two inputs MRa and MRb for remote billing reset. In normal state signal at the first input is high and on the other is low. In order to perform the billing reset signals on both inputs should be changed from high to low and from low to high in an optional long time span.



Note
At meter ordering it should be specified whether the meter is to be equipped with inputs for remote billing reset or not.

6.2. TEMPORALLY DISABLING OF BILLING RESET

When a billing reset is performed by pressing the Reset pushbutton or via a communication interface a new billing reset by the same means is disabled for a certain time. This time can be programmed in a range from 0 to 65535 minutes (45 days) in a register **C.55.1.** When this time elapses, the billing reset can be repeated by the same means.

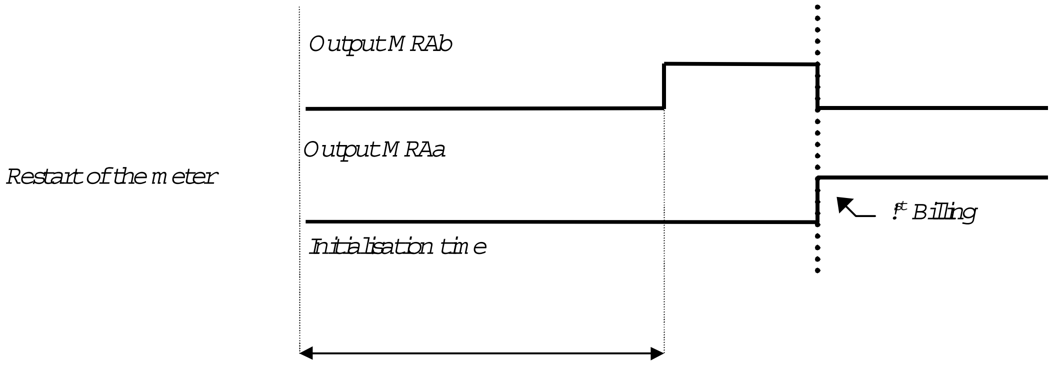
Note that billing reset is temporally disabled only for manual reset via the Reset pushbutton or via a communication interface but not for remote billing reset via the inputs MRa and MRb or by the internal tariff device.

6.3. MRAA AND MRAB BILLING RESET OUTPUTS

The TE851 meters can be equipped with two outputs MRAa and MRAb for billing reset of an external meter. At normal operation there is signal low at one output and high on the other. At billing reset of an external meter, both signals change their polarity, i.e. from low to high at the first output and from high to low at the second output (or vice versa) in a short time span.

Note
At meter ordering it should be specified whether it has to be equipped with billing reset outputs or not.

The figure shows how outputs at a billing reset operate and the operation procedure at the meter restart (e.g. at the end of power failure). A standard operation version is shown in the figure below. Both inputs represent a binary combination, which can have values from 0 to 3. MRAa represents the b0 bit and MRAb the b1 bit.



During the program initialisation both outputs have value 0 and at its end MRAb becomes 1. Both outputs change their values at a billing reset.

6.4. BILLING DATA

The following data stored at billing reset:

- data on measured quantities
- data on billing period completion

6.4.1. Data on measuring quantities

Each billing period involves data on:

- cumulative energies
- cumulative tariff energies
- tariff maximum demands
- cumulative tariff maximum demands

All data, except cumulative maximum demands, are indexed with an index of previous values. The previous values are values registered in corresponding previous billing periods.

Cumulative maximum demands are unique data to which billing tariff maximum demands are added at every billing reset while values of previous billing periods are not stored.

6.4.1.1. Indexing of previous values

The format of previous values (metering data belonging to previous billing periods) is as follows:

EDIS code	Delimiter	Index of previous value	Value
1.8.2	*	01	(000003.93*kWh)

6.4.1.1.1. REGISTER CODE

Usually this is the code as it is defined by EDIS recommendation. On a special request it is possible to implement a different (custom) code.

6.4.1.1.2. Indication of billing reset Type

Type of billing reset performed in previous months is indicated with a delimiter positioned between the EDIS code for data identification and a number that indicates to which previous month the data belong. The following delimiters are used for indicating type of performed billing reset:

Delimiter	*Billing reset type*
&	*billing reset is performed by means of RESET pushbutton*
#	*billing reset is performed by a command via communication interface*
*	*billing reset was performed by the internal tariff device*
$	*billing was performed by external signal applied to the remote reset input*
?	*invalid data due to incorrect check sum*
=	*empty register (data has not been entered yet)*

6.4.1.1.3. Index OF PREVIOUS VALUES

The index of previous can be linear or circular and is programmable in the register **C.59.3** as follows

Index of previous values	Value in register C.59.3
Linear	**0**
Circular (00 through 99)	**1**

6.4.1.1.3.1. Linear index

Linear index goes from 0 to N_{pr}, where:

0 - which represents a momentary value and is not listed

N_{pr} - a number of previous values that are stored in the memory.

The example shows indexing; in this case for N_{pr} = 5.

Example of listing:

1.8.2(000004.28*kWh) - data of a current billing period

1.8.2*01(000003.93*kWh) - data of the last billing period (billing reset performed by int. tariff device)

1.8.2*02(000003.18*kWh) - data of one billing period before the last one (billing reset performed by the internal tariff device)

1.8.2&03(000003.04*kWh) - data of two billing periods before the last one (billing reset performed by means of Reset pushbutton)

1.8.2*04(000002.38*kWh) - data of three billing periods before the last one (billing reset performed by the internal tariff device)

1.8.2#05(000002.14*kWh) - data of four billing periods before the last one (billing reset performed by command received via a communication interface)

In case of linear indexing data of the last billing period always have number 01, data of a billing period before that have a number 02, etc.

6.4.1.1.3.2. Circular index

In this case each billing period gets its characteristic number and keeps it during the storage procedure. Each new billing period gets an index, which is incremented by 1 regarding the previous billing period. When a billing period obtain indexes of a maximum set value - e.g. 100 (=00), the next billing period gets again index 01. With next billing reset the index is incremented by 1 and the whole cycle of incrementing index at each reset is repeated. Therefore indexes of previous billing periods permanently circulate.

An example of circular indexing with data stored for 15 previous billing periods:

*1.8.0(000005.16*kWh) - data of the current billing period*

*1.8.0*12(000004.71*kWh) - data of the last billing period (billing reset performed by int. tariff device)*

*1.8.0*11(000003.93*kWh) - data of the billing period before the last one (reset performed by the internal tariff device)*

*1.8.0*10(000003.18*kWh) - data of 2 billing periods before the last one (reset by the int. tariff device)*

*1.8.0&09(000003.04*kWh) - data of 3 billing periods before the last one (reset by Reset pushbutton)*

*1.8.0*08(000002.38*kWh) - data of 4 billing periods before the last one (reset by the int. tariff device)*

*1.8.0#07(000002.14*kWh) - data of 5 billing periods before the last one (reset by a command via communication interface)*

*1.8.0&06(000001.63*kWh) - data of 6 billing periods before the last one (reset by the int. tariff device)*

*1.8.0*05(000001.59*kWh) - data of 7 billing periods before the last one (reset by the int. tariff device)*

*1.8.0*04(000000.80*kWh) - data of 8 billing periods before the last one (reset by the int. tariff device)*

*1.8.0#03(000000.65*kWh) - data of 9 billing periods before the last one (reset via communicat. interf.)*

*1.8.0&02(000000.55*kWh) - data of 10 billing periods before the last one (reset by Reset pushbutton)*

*1.8.0*01(000000.00*kWh) - data of 11 billing periods before the last one (reset by the int. tariff device)*

*1.8.0=00(000000.00*kWh) - register for data of 12 billing periods before the last one (data not entered)*

*1.8.0=99(000000.00*kWh) - register for data of 13 billing periods before the last one (data not entered)*

*1.8.0=98(000000.00*kWh) - register for data of 14 billing periods before the last one (data not entered)*

As only 12 billing resets have been performed yet, the registers for data of 13, 14 and 15 months ago are still empty.

Note
At meter ordering it is necessary to specify in which form indexes of previous values are to be indicated.

6.4.2. Data on billing period

Every billing period contains date and time when the billing occurred (time stamp), how was performed the billing reset and status of a billing validity.

6.5. NOTATION OF DATA ON MEASURED ENERGIES IN PREVIOUS BILLING PERIODS

Billing data on measured energy can be stored and listed as:

- absolute value
- delta value (difference)

Absolute value: values of cumulative energy registers of individual energies are stored at the end of billing period.

Delta value: differences of cumulative energy registers of individual energies of two successive billing periods are stored.

In the following table are given examples of notations of measured energies in registers of previous billing periods:

Previous billing period	Absolute value +W (kWh)	Delta value +W (kWh)
23	3456,56	240,45
24	3687,86	231,30
25	3898,12	210,26
26	4120,88	222,76

Note
At ordering the meter it is necessary to specify whether billing data for energy have the form of a register absolute value or a form of a difference, (energy is measured in a period during billing resets).

7. LOAD PROFILE (LP) RECORDER

On request the TE851 meters can be equipped with a load profile recorder. It is a functional unit which registers demands for each load profile period as well as some other quantities, meter status and events. Each data in the data recorder is accompanied with date and time of the end of a load profile period to which it relates.

The LP in the TE851 meter enables registration and presentation of the following data:

- Three-phase demands of a four-quadrant measurement: +P, -P, Q1, Q2, Q3, Q4
- Demands of reactive energy in combined quadrants: e.g. Q1+Q2, Q3+Q4…
- All types of event counters: e.g. a counter of voltage failures, a reset counter, etc.
- Different combinations of device statuses which were valid at the sampling moment: e.g. direction of energy flows, data recording control statuses, etc.

Definitions of terms of a load profile recorder

CHANNEL - every registered quantity occupies one channel of the LP recorder.

Example: Registration of +P, -P, Q1, Q2, Q3, Q4 demands occupies six channels

Channel 1	*+P*
Channel 2	*-P*
Channel 3	*Q1*
Channel 4	*Q2*
Channel 5	Q3
Channel 6	*Q4*

STATUSES - are logical variables that indicate meter status. They can be displayed on the LCD, transferred to the output terminals, transmitted via communication interfaces or registered by the LP recorder.

Examples of statuses:

Active tariff for power: occupies 3 bits
Active tariff for energy: occupies 3 bits
Disabling of demand measurement: occupies 1 bit
Energy flow direction: occupies 1 bit
Activated load limiter at channel 3: occupies 1 bit

TIME OF RECORD - time of the end of a load profile period (hh:mm) to which data is related or at which it was sampled

READOUT ELEMENT - is a registered value of a certain channel at a **time of record**

Example
__Readout element:__ channel 1, record element 2: 33.557

RECORD ELEMENT - are READOUT ELEMENTS of all individual channels and the times of records

Example:

Record element	Record time	Channel 1 $+W_{kum}$ (kWh)
1.	*00:15*	*32,556*
2.	*00:30*	*33,557*

CHANNEL RECORD - a sequence of readout elements of a channel

Example of a section of a channel record:

Load profile period T_{per} = 15 min

+P (MW)   t (hh:mm)

.. .. ..
(0.861 20:00
(0.860 20:15
(0.861 20:30
(0.859 20:45
(0.859 21:00
(0.858
(0.854
(0.857
(0.852 22:00
(0.858
(0.857
(0.846
(0.824 23:00
(0.814
(0.810
(0.800
(0.808 00:00
(0.805
(0.811
(0.806
(0.809 01:00
(0.812
(0.824
(0.834
.. .. .. 02:00

LOAD PROFILE PERIOD - period of the load profile recorder with which data are stored in it.

7.1. BASIC DATA ON LOAD PROFILE RECORDER

Basic data of a load profile recorder are: a number of channels, extent of registration and load profile period.

7.1.1. A number of channels

The recorder in the TE851 meter can have up to 32 channels and 8 status bits, i.e. data profile can be registered for up to 32 quantities.

Note
At meter ordering a number of channels should be specified. If 0 is specified, it means that the ordered meter will not perform load profile registration.

7.1.2. Capacity of load profile recorder

A number of days for which data are stored in the load profile recorder depends on a load profile period, a number of statuses registered (if any) and a number of channels (i.e. a number of quantities, statuses and events that are registered). Capacity of the load profile memory expressed in a number of days for which data are stored, depending on load profile period 15 and 30 minutes, as well as on numbers of statuses and channels are given in a table bellow:

LP period (min.)	Statuses (no. of bits)	Number of channels	LP capacity (days) (resolution 1 bit)		Compact record (accuracy 0.0015)	
			*1	*2	*1	*2
15	0	4	90.6	94.2	130.8	138.5
15	8		84.1	87.2	**117.8**	123.9
15	0	8	47.1	48.1	69.3	71.4
15	8		45.3	46.2	**65.4**	67.3
15	0	16	24.0	24.3	35.7	36.2
15	8		23.5	23.8	34.6	35.1
15	0	32	12.1	12.2	18.1	18.2
15	8		12.0	12.1	17.8	18.0
30	0	1	588.8	672.9	785.1	942.1
30	8		471.0	523.4	588.8	672.9
30	0	2	336.4	362.3	471.0	523.4
30	8		294.4	314.0	392.5	428.2
30	0	4	181.2	188.4	261.7	277.1
30	8		168.2	174.5	**235.5**	247.9
30	0	8	94.2	96.1	138.5	142.7
30	8		90.6	92.4	**130.8**	134.6
30	0	16	48.1	48.5	71.4	72.5
30	8		47.1	47.6	69.2	70.3
30	0	32	24.3	24.4	36.2	36.5
30	8		24.0	24.1	35.7	35.9

*1 - each sample has its check sum
*2 - every second sample has its check sum

If a load profile period T_{lp} is shorter than 15 minutes, a number of days for which load profile data are stored in the recorder should be divided with a ratio 15/ T_{lp} considering a corresponding number of channels and statuses. If it is longer than 15 minutes, a number of days for which load profile data are stored in the recorder should be multiplied with a ratio $T_{lp}/15$ considering a corresponding number of channels and statuses.

7.1.3. LP period

A LP period can be optionally set in range from **1 minute to 60 minutes** with resolution 1 minute. However, such a value should be selected for the load profile period that it is contained in a day without a residuum.

As a day is 1440 minutes long, the permitted lengths of LP period (expressed in minutes) are thus:
1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 15, 16, 18, 20, 24, 30, etc.

Note
The LP period length is programmable.

7.2. QUANTITY REGISTRATION

The LP recorder can record three basic types of quantities:

- measured quantities
- counters of events and time
- statuses of device and measuring situations

Note
Contents of channels are programmable via remote or local communication.

7.2.1. Measured quantities registered by load profile recorder

TE851 enables registration of the following measured values:

- Three-phase demands of energies in a four-quadrant system: +P, -P, Q1, Q2, Q3, Q4
- Demands of reactive energy in combined quadrants: e.g. Q1+Q2, Q3+Q4…

Note
Quantities that will be registered by the load profile recorder are programmed via a communication interface.

7.2.2. Counters of events and time registered by load profile recorder

The LP recorder can also record the state of counters of events or time in the TE851 meter. The state of counters and events are registered at the moment of the end of the load profile period. The counters of events and time are described more in detail in a special chapter.

Value of the counter is recorded at the moment of the end of the LP period.

If power failure occurs in that moment and the counter is inactive, 0 is entered.

Note
Counters that are to be registered by the LP recorder are programmable via communication interface.

Example
Counters of phase voltages L1, L2, L3 failures.In this way it is possible to monitor when voltages failed.out of limits were occurred.

A list of registration of counters of voltages failures phase L1:

37	20:00			
37	20:15			
37	20:30			
37	20:45	from 20:45 to 21:00 failure39	21:00	occurred twice
39				
39				
39				
39	22:00			
39		from 22:15 to 22:30 failure40		occurred once
40				
40	23:00			

7.2.3. Device statuses and measuring situations

The LP recorder can also register the state of any status of the TE851 meter. Status bits (flags) are associated into bytes (groups of eight bits). The status bytes are registered at the end of the LP periods. Status arrays with 0, 8, 16, 24, 32 status bits is available in the LP recorder.

Note
A size of status array should be specified when ordering the meter. Contents of the status array are programmable via communication interface.

Example

The TE851 meter with 8-bit status array.

BIT	Status
1	Error on vital data
2	Error on time of billing resets
3	Error on tariff program
4	Error on configuration data
5	Error on momentary time of RTC
6	History error on RTC
7	Disabling of billing reset by means of Reset pushbutton
8	Disabling of billing reset via communication interface

7.3. DATA REGISTRATION BY LOAD PROFILE RECORDER

Data can be registered by a load profile recorder:

- Every second
- At the end of the LP period

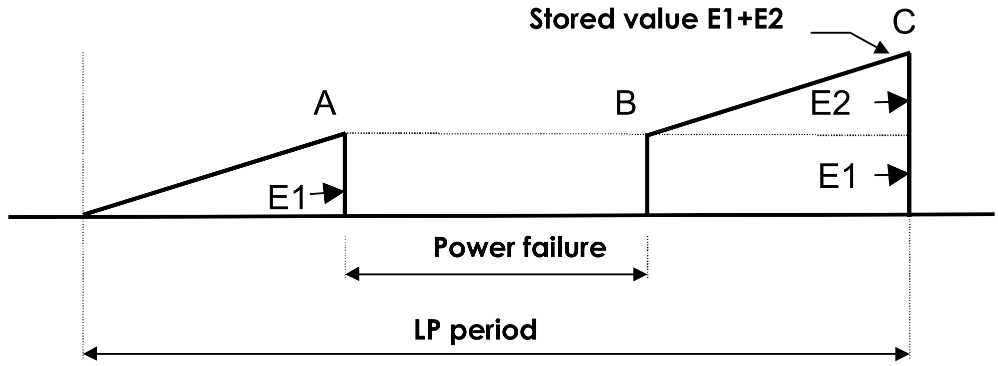
7.3.1. Variables which are entered every second

Demands of active and reactive energies (+P, -P, Q1, Q2, Q3, Q4) as well as demands of energies in combined quadrants, e.g. Q1+Q2, Q3+Q4 are registered every second. By entering data every second into the LP recorder an accurate recording is assured also in case of power shortages.

At the end of the LP period the values are stored as a readout element.

7.3.1.1. Load profile registration in case of short power failures

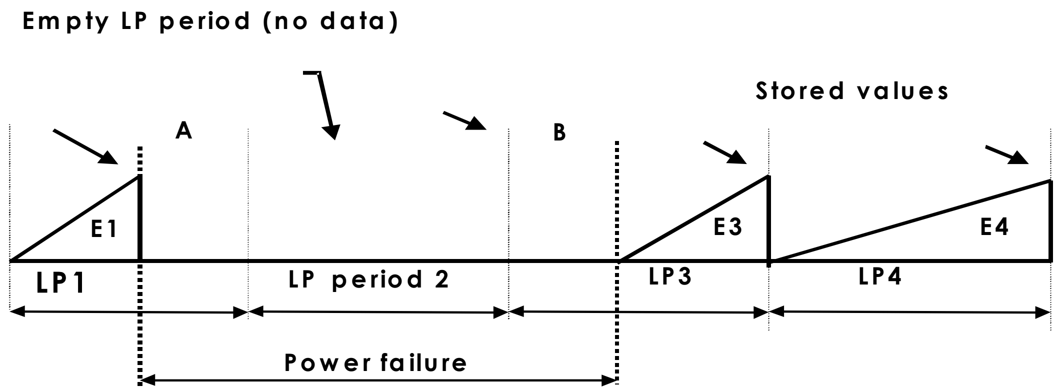
If during the LP period a short power failure occurs, the load profile recorder operates as follows:



At the moment of power failure (point A in the diagram) the energy E1 is registered in a corresponding register of the load profile recorder. As the value of energy was stored every second into the register, this value is actual energy in the current period. At the end of power failure (point B in the diagram) the registration is continued where it was ended at the moment of power failure. Therefore, at the end of the LP period a total measured energy (i.e. E1+E2) is registered.

7.3.1.2. Load profile registration in case of long power failures

If a power failure longer than the LP period occurs, the load profile recorder operates as follows:



At power failure (point A in the diagram) the value is stored in a corresponding register as in the previous case. When voltage is restored (point B in the diagram):

- E1 is entered into the corresponding register for the LP1 period
- 0 is entered into the corresponding register for LP2 period (if power failure lasted longer than the LP period, zero is entered for the LP periods which are within the power failure time span)
- energy E3 is measured from the beginning of voltage restoration (point B in the diagram) and recorded at the end of LP3 into the corresponding register

Therefore:

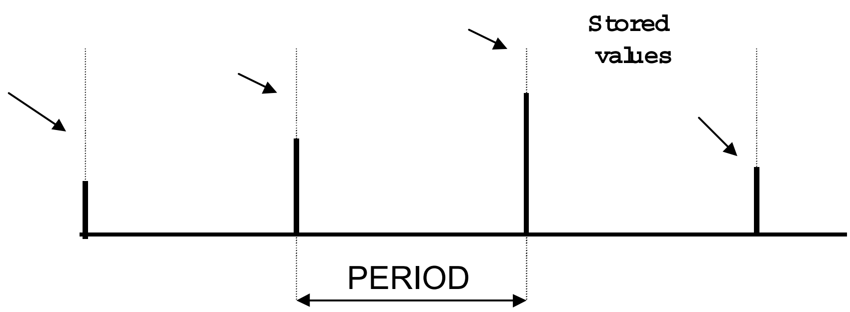
- The LP period continues regardless of power failures
- In each record a valid value of measured energy is stated
- All LP periods during power failure are registered and have value 0.

Example
The customer's demand is very constant. A power failure occurred at 22:17 and ended at 23:18. Note that in the third load profile period is registered lower load than in the first two due to power failure that occurred at that time. In the next three load profile periods there was power shortage therefore 0 load is registered. During the last load profile period the power supply was restored, therefore registered load is lower than in the first two load profile periods.

0.852	22:00
0.858	22:15
0.121	22:30
0.000	22:45
0.000	23:00
0.000	23:15
0.669	23:30

7.3.2. Variables which are registered at the end of a LP period

All other quantities that are registered by the load profile recorder are recorded at the moments of the end of LP periods. They are momentary values at the end of the LP period and are, therefore, not registered during the LP period. This can be represent by the following diagram:



In case of short power failure it does not have any influence on the recorder. If failure is longer, the values in time span of power shortage are equal to 0.

8. LOAD LIMITER

The TE851 meters can be equipped with a load limiter. It enables to keep the energy demand under the contractual demand level. Up to 3 independent load limiters ca be built into the meter.

The load limiter can be used either for indication of exceeded demand or for automatic control of load at a consumer side and thus keeping demand under the contractual demand.

The load limiter calculates either demand or trend of demand in a current demand period and if demand is equal to the contractual demand emits a signal that is fed to the corresponding control output(s) or transferred via a communication interface (e.g. CS 20-mA loop).

The following demands: +P, -P, Q1, Q2, Q3, Q4 or demands of energies in combined quadrants, e.g. Q1+Q2, Q3+Q4 can be used for limiting load.

Note
At meter ordering, a number of control outputs (channels) in the meter and energy related to the selected channel on the basis of which the load control is performed should be specified.

8.1. DESCRIPTION OF LOAD LIMITER FUNCTION

The load limiter can operate in two modes

- ON / OFF controller
- 3-point controller

The load limiter mode (an ON / OFF or a 3-point controller) and parameters for load control are programmable. The following parameters of load control should be programmed:

- contractual demand (for both modes)
- ± tolerance for demand expressed in percentage (in case of a 3-point controller)
- time span (expressed in percentage) at the beginning of the demand period in which trend of demand is not calculated (in case of a 3-point controller)

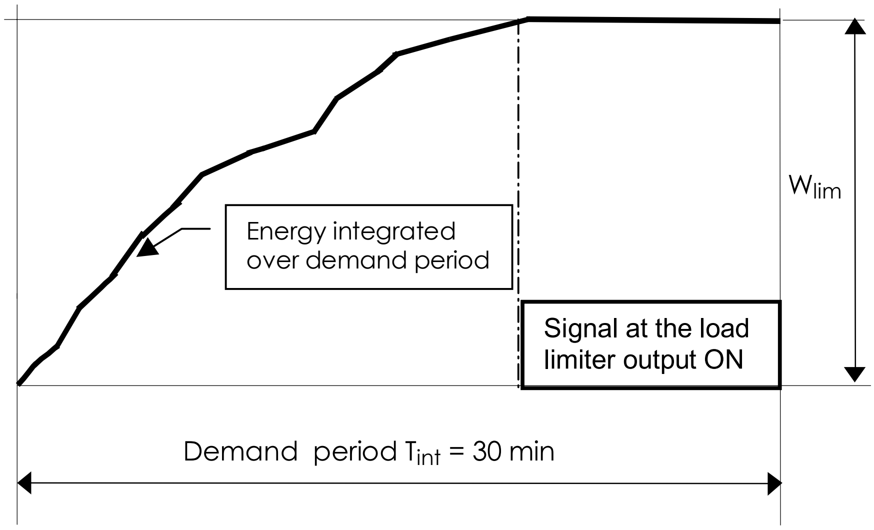
8.1.1. Load limiter in ON / OFF controller mode

Operation of the load limiter in the ON / OFF controller mode is based on energy integrated over the elapsed time of the demand period. This energy is compared with energy W_{lim} integrated over the demand period T_{int} at **contractual demand** P_{lim}.

$$W_{lim} = P_{lim} \times T_{int}$$

If energy integrated over the elapsed time of the demand period reaches the W_{lim}, the load limiter generates a signal which is fed to the corresponding load control output or can be transmitted via a communication interface. The control output can be used either for remote warning that the contractual demand P_{lim} is exceeded or for control of the load. In the last case the load is shut down by means of an actuator controlled by the signal on the load control output of the meter. The signal at the load control output remains till the end of the demand period, thus the load is shut down till the end of the demand period. At the beginning of the next demand period the signal at the load control output is cancelled and thus the load is turned-on. In this way contractual demand P_{lim} is never exceeded, but customer can stay without power supply for a certain time.

Example
Contractual demand is P_{lim} = 300 kW.
Length of demand period is T_{int} = 30 min, therefore permitted energy consumed in the demand period is W_{lim} = 150 kWh. Operation of the load limiter is shown in the figure below.



Load control procedure: when integral of demand over the elapsed time in a current demand period reaches contractual energy consumption for the whole demand period, a control output is activated. It remains active till the end of the demand period.

8.1.2. Load limiter in 3-point controller mode

Operation of the load limiter in the 3-point controller mode is based on calculation of trend of demand in demand period. This trend is compared with the **contractual demand P_{lim}**. If the trend of demand is greater than

$$W_{lim}(1+0.01\times\Delta_{lim})$$

where Δ_{lim} is tolerance of demand, expressed in percentage, a control signal is fed to the load control output. It is used to shut down part of the load via an appropriate actuator. Consequently demand will be decreased. When demand is decreased bellow

$$W_{lim}(1-0.01\times\Delta_{lim})$$

the signal on the load control output is cancelled and as result part of the load is turned-on. If demand is not decreased under this value, the signal remains on the load control output and consequently part of the load is turned-off till the end of the demand period.

At the beginning of demand period there is just few pulses of energy, so that calculation of trend of demand is inaccurate. This could cause sequentially turn-off and turn-on of part of the load. Therefore control of load is disabled at the beginning of the demand period to prevent unnecessary disturbances in power supply.

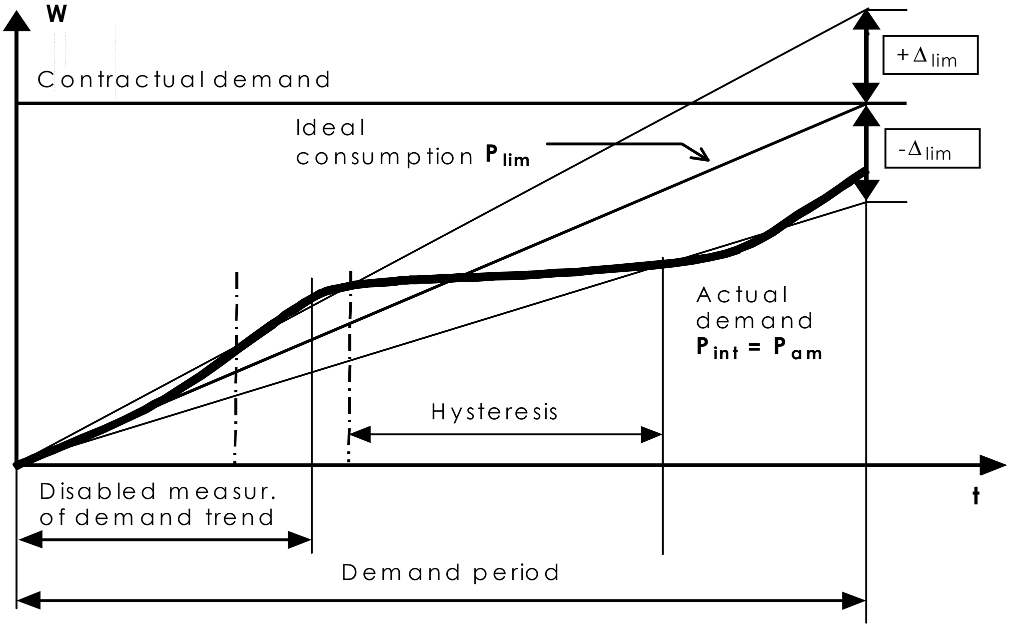
Operation of the load limit er in the 3-point controller mode is defined contractual demand P_{int}, demand tolerance Δ_{lim} and load control disable interval T_{blo}.

Note
Contractual demand P_{int}, demand tolerance Δ_{lim}, and load control disable interval T_{blo} are programmable.

Example
A load limiter in 3-point controller mode is defined with the following parameters:

Contractual demand P_{lim} = 300 kW, demand tolerance Δ_{lim} = 7%, load control disable interval T_{blo}=40% (in order to get better resolution of the diagram. In reality load control disable interval is in a range from 1% to 5%).

Load limiter operation is shown in the figure.



The course of load control in the shown example: momentary demand is within a tolerance range up to point A. At point A the momentary demand exceeds the upper limit of demand tolerance 321 kW. The load control output is not activated as the load control is disabled inside T_{blo} interval. Therefore the load control output is activated at the end of the load control disabled interval (point B) and remains active up to the point C when momentary demand is decreased under the lower limit of demand tolerance, i.e. under 279 kW. As in this demand period the upper tolerance limit is not exceeded again, the load control output remains inactive up to the end of the demand period.

8.2. CONFIGURATION OF LOAD LIMITER

When ordering the meter the load limiter hardware are to be specified:

- a number of load limiter channels: 0, 1, 2 or 3
- a number of physical load limiter outputs: 0, 1, 2, 3

8.2.1. Programming the load limiter

A load limiter is programmed in the factory in compliance with the customer's specification. The load limiter can also be programmed on the field via local or remote communication.

Mode of load control is programmed for each channel: ON/OFF controller or 3-point controller.

It is possible to program a number of channels with ON/OFF controllers or 3-point controllers, i.e. up to 3 channels or up to 3 channels with 3-point controller as well as any combination of ON/OFF and 3-point controllers by setting corresponding bit values in the **N_452** register.

Register N_452	Bit value	Load limiter
Bit 0	0	First channel: ON/OFF controller
	1	First channel: 3-point controller
Bit 1	0	Second channel: ON/OFF controller
	1	Second channel: 3-point controller
Bit 2	0	Third channel: ON/OFF controller
	1	Third channel: 3-point controller
Other bits (3, 4, …7) are not used		

ON/OFF controllers are programmed by entering contractual demand $\mathbf{P_{lim}}$ for each channel into the register **N_451**.

3-point controllers are programmed by entering contractual demand $\mathbf{P_{lim}}$ for each channel into the **N_451** register. The demand tolerance $\mathbf{\Delta_{lim}}$ (register **N_453**) and interval of disabled load control $\mathbf{T_{blo}}$ (register **N_454**) are programmed for all load control channels that operate in 3-point controller mode.

Input quantities of load controller channels can be +P, -P, Q1, Q2, Q3, Q4 .

Example of setting the load limiter

A load limiter with three load control channels:

1st channel: ON/OFF controller, input quantity Q1 , $Q1_{lim}$ = 200 kVAr

2nd channel: 3-point controller, input quantity +P , +P = 250 kW

3rd channel:3-point controller, input quantity +P , +P= 450 kW

A common setting of load control channels with 3-point controllers: tolerance of demand Δ_{lim} = 7%, load control disabled interval T_{blo} = 35%.

Note

Tolerance of demand Δ_{lim} = 7% and load control disabled interval T_{blo} = 35% do not influence operation of the ON/OFF controller.)

9. METER HANDLING AND DATA DISPLAYING

The TE851 meters employ menu driven data display that is controlled by two pushbuttons: Scroll and Reset. They are located on the meter front side. The Scroll pushbutton is the upper one. The Reset pushbutton is under the Scroll button. It can be sealed separately from the meter cover.
Different commands can be executed by the pushbuttons depending on a sequence they were pressed as well as how long time the Scroll pushbutton was depressed. Reliability of executing commands is increased by eliminating effect of the contact bounce. Both handling of the LCD and editing of programmable parameters are performed by one hand, i.e. there is no need to activate a couple of control elements simultaneously.

The following commands can be performed:

<u>Scroll pushbutton</u>

- **button short depressed ($t_{depress}$ < 2 s)** - next value in the list or next item in the menu is selected
- **button long depressed (2s ≤ $t_{depress}$ < 5s)** - either activates displayed menu item or skip into displaying of the previous values (metering data of the previous billing periods)
- **button extended depressed ($t_{depress}$ ≥ 5 s)** - abandon selected data displaying and skip back into the AUTO mode of data displaying (data scrolling mode)

<u>Reset pushbutton</u>

- **button optional long depressed** - reset of the meter except in the setting mode or during the LCD test
- **button optional long depressed** - in the setting mode cause entering of edited digits or values into the memory

9.1. DATA DISPLAY AND LCD CONTROL

For displaying of data/values on the LCD there are the following data display modes:
⇒ automatic sequence of data display mode
⇒ test of LCD
⇒ sequence of data display on request "menu Scroll pushbutton"
⇒ data display on request Standard ("Std-dAtA" - display of data stored in all registers in the list)
⇒ data display on request Load-profile ("P.01" - display of load-profile data)
⇒ mode on request "menu Reset pushbutton"
⇒ setting mode ("Set" - editing of programmable parameters)
⇒ high resolution of displayed values mode for meter testing purpose ("tESt" mode)

Note
In the high resolution mode energy data are displayed with resolution of 5 decimal digits in order to shorten time of meter testing at low loads. On request in high resolution mode energy data can be displayed with resolution of 2 additional decimal digits regarding the standard data resolution.

A basic LCD mode of data displaying is AUTO - automatic sequence of data displaying. The LCD returns back into the AUTO mode from any mode (i.e. data display on request mode, load profile data mode, parameters setting mode or test mode) automatically if no control pushbutton has been depressed in a time span equal to 2 demand periods (e.g. 30 minutes, if demand period is 15 minute) or if the Scroll pushbutton was hold depressed longer than 5 seconds.

When the last data in the list was displayed, a message "End" is displayed on the LCD, indicating that there is no more data to be displayed.

<u>For the Scroll pushbutton valid the following:</u>

In the data display on request mode "Menu":

- display of the next value in the list (pushbutton depressed < 2 s),
- selection of values from the displayed list (pushbutton depressed ≥ 2 s).

In the data display on request mode "Standard":

- display of the next value / previous value (pushbutton depressed < 2 s),
- skip to display of previous values (pushbutton depressed ≥ 2 s).

In the data display on request mode "Load profile":

- move forward to the next day data-block (pushbutton depressed < 2 s),
- selection of the displayed day data-block (pushbutton depressed ≥ 2 s).

In the day data-block:

- move forward to the next available load-profile period (pushbutton depressed < 2 s),
- return back to the previously selected day data-block (pushbutton depressed ≥ 2 s).

In the "Setting" mode:

- A flow chart of editing meter parameters with the pushbuttons is shown in Fig. 9.6 (item 9.1.6)

In the "High resolution" mode:

- display of next testing value (pushbutton depressed < 2 s),
- skip of the displayed previous values (pushbutton depressed ≥ 2 s).

In the Set mode values can be also edited via communication interfaces. Therefore parameters editing via a communication interface and a control pushbutton disable each other. Data are displayed on the LCD in the same sequence as their EDIS identification codes both in the AUTO mode of data display and in the data display on request mode. The first data displayed on the LCD is "error" (EDIS identification code "F.F"). After it metering quantities are displayed on the LCD in sequence ordered by their increasing EDIS identification codes read from left to right. Exception from this rule is displaying of the previous values (data registered in previous billing periods). They are always displayed in order from the newest billing period to the oldest one.

9.1.1. AUTO mode of data display

Auto mode of data display is a standard mode of the LCD. Data are scrolled automatically and are displayed for 10 seconds each. A list of data that are displayed in the AUTO mode can be programmed in the meter parameterisation mode.

Example
A list of data displayed in the AUTO mode for a 4-quadrant meter with 2-rate registration is given in the following table.

Item	EDIS code	Displayed quantity
1.	1.4.1	+P demand in current demand period, tariff M1(kW)
2.	1.4.2	+P demand in current demand period, tariff M2(kW)
3.	1.6.1	+P maximum demand in current billing period, tariff M1(kW)
4.	1.6.2	+P maximum demand in current billing period, tariff M2(kW)
5.	1.8.1	+A active energy, tariff T1 (kWh)
6.	1.8.2	+A active energy, tariff T2 (kWh)
7.	2.4.1	-P demand in current demand period, tariff M1(kW)
8.	2.4.2	-P demand in current demand period, tariff M2(kW)
9.	2.6.1	-P maximum demand in current billing period, tariff M1(kW)
10.	2.6.2	-P maximum demand in current billing period, tariff M2(kW)
11.	2.8.1	-A active energy, tariff T1 (kWh)
12.	2.8.2	-A active energy, tariff T2 (kWh)
13.	5.8.1	R1 reactive energy in quadrant Q1, tariff T1 (kvarh)
14.	5.8.2	R1 reactive energy in quadrant Q1, tariff T2 (kvarh)
15.	6.8.1	R2 reactive energy in quadrant Q2, tariff T1 (kvarh)
16.	6.8.2	R2 reactive energy in quadrant Q2, tariff T2 (kvarh)
17.	7.8.1	R3 reactive energy in quadrant Q3, tariff T1 (kvarh)
18.	7.8.2	R3 reactive energy in quadrant Q3, tariff T2 (kvarh)
19.	8.8.1	R4 reactive energy in quadrant Q4, tariff T1 (kvarh)
20.	8.8.2	R4 reactive energy in quadrant Q4, tariff T2 (kvarh)

9.1.2. LCD test

LCD test is performed whenever mode of operation is changed from AUTO mode of data display to "menu Scroll pushbutton" mode (meaning data displaying on request, either Standard data or Load profile data) or "menu Reset pushbutton" mode (meaning parameters setting or high resolution data display mode). When the Scroll pushbutton is depressed in the AUTO data display mode, the LCD is illuminated. Time of the LCD illumination is programmable in the register **C.55.10**.

With next depress of the Scroll pushbutton the LCD is tested. The following is happened during the LCD test:

- VDEW designed LCD

All segments of the LCD are turned-on during the test.

After the LCD test was performed the following modes can be selected:

- Menu Scroll pushbutton - by depressing the Scroll pushbutton
- Menu Reset pushbutton - by depressing the Reset pushbutton

9.1.3. Data displayed on request mode - Menu Scroll pushbutton

The first displayed item in the menu is a list of single data named "Standard data" ("Std-dAtA"). With each following short (<2 s) depress of the Scroll pushbutton the next list of data from the Menu Scroll pushbutton is displayed, e.g. a load profile list "P.01". The displayed list of data can be selected by holding the Scroll pushbutton depressed at least 2 seconds (long depress of the Scroll pushbutton).

The last data in the selected list of data is a message "End" displayed in the value part of the LCD, indicating that there is no more data in the list.

If no pushbutton is depressed in a time span longer than demand period (or load profile period, if there is no demand period; e.g. 15 minutes) or if the Scroll pushbutton was depressed for more than 5 seconds (extended depress of the Scroll pushbutton) the LCD returns back into the automatic sequence of data display mode.

9.1.3.1. Standard data list

A list of Standard data is displayed on request. The first data displayed in the "Std-dAtA" list is the identification code and data on Function errors. Each following depress of the Scroll pushbutton displays the next data from the list. By holding the Scroll pushbutton depressed more than 2 seconds the previous values (data belonging to the previous billing periods) can be skipped, so that the next data is displayed. In this way data can be faster over-viewed. If no pushbutton is depressed in a time span longer than a demand period (or load profile period, if there is no demand period; e.g. 15 minutes) or if the Scroll pushbutton was depressed for more than 5 seconds (extended depress of the Scroll pushbutton) the LCD returns back into the AUTO mode of data display. In this way is assured that data can be displayed uninterrupted at least over one complete demand period.

Data from the Standard data list can be also scrolled by illuminating the photo-transistor of the IR optical port with a pocket torch longer than the communication time. This feature is useful when the meter is built in a locked cabinet with a glass window, so that the Scroll pushbutton can not be pressed.

The last data displayed in the "Std-dAtA" list is a message "End". It is displayed in the value part of the LCD, indicating that there is no more data in the list to be displayed.

9.1.3.2. Load profile data list

A list of Load profile data is displayed on request. The first data displayed in the "P.01" list is a date of the newest available day data-block in the load profile. Each following short (<2 s) depress of the Scroll pushbutton displays the available day data-block a day back in the load profile. If the Scroll pushbutton is hold depressed longer than 2 seconds, the selected day data-block of the load profile can be reviewed in detail by displaying data-by-data of each incremented load profile period. Data of some profile period can be missed or some demand periods can be shorten due to events that happened during that load profile period.

If no pushbutton is depressed in a time span longer than double load profile period or if the Scroll pushbutton was depressed for more than 5 seconds (extended depress of the Scroll pushbutton) the LCD returns back into the AUTO mode of data display. The last data displayed in the "P.01" list is a message "End". The message is displayed after the oldest available date of the day data-block, indicating that there is no more day data-blocks to be reviewed.

Values of a load profile of selected day

Data display of the selected day data-block starts with the oldest (i.e. the first) value of the load profile recorded on that day. Note that time of a load profile data registration represents the end of the corresponding LP period, therefore data with time 00:00 is the last one in a day data-block. On the most left side of the LCD is displayed the EDIS code of the data. With each following short depress of the Scroll pushbutton the next data of the first load profile period is displayed. When all data from the first LP period were displayed, the first data from the second LP period is displayed. This procedure is repeated with each short depress of the Scroll pushbutton till the last data of the last available LP period in the selected day data-block is displayed.

The last data in the selected day data-block is a message "End", displayed in the value part of the LCD. It indicates that there is no more data in the day data-block to be displayed. If the Scroll pushbutton is hold depressed for at least 2 seconds (long pushbutton depress), the date of just reviewed day data-block is displayed.

If no pushbutton is depressed in a time span longer than double demand period or if the Scroll pushbutton was depressed for more than 5 seconds (extended depress of the Scroll pushbutton) the LCD returns back into the automatic sequence of data display mode.

9.1.4. Menu Reset pushbutton

The Reset pushbutton menu is displayed on request. The first displayed item in the menu is the setting mode named "SEt". With each following short (<2 s) depress of the Scroll pushbutton the next item in the menu is displayed, e.g. high resolution of data display mode named "tESt" which is used for meter testing. The displayed mode can be selected by holding the Scroll pushbutton depressed at least 2 seconds (long depress of the Scroll pushbutton).
The last data in the selected mode is a message "End" displayed in the value part of the LCD. It indicates the end of the Reset pushbutton menu.
If no pushbutton is depressed in a time span longer than demand period (or load profile period, if there is no demand period; e.g. 15 minutes) or if the Scroll pushbutton was depressed for more than 5 seconds (extended depress of the Scroll pushbutton) the LCD returns back into the automatic sequence of data display mode.

9.1.4.1. Setting mode ("SEt" mode)

The meter is set into the setting mode when in the Reset pushbutton menu the item "SEt" is displayed on the LCD and the Scroll pushbutton is hold depressed for more than 2 seconds. The cursor SET starts to blink indicating that the meter is in the setting mode.
In the meter setting mode parameters can be either edited by means of the Reset and/or Scroll pushbuttons or entered into the memory via communication interfaces. These two functions disable each other:
While parameters are being edited by means of the pushbuttons, i.e. when a digit of edited data is blinking on the LCD, parameters entering via communication interfaces is disabled.
When parameters are being entered via a communication interface, parameter editing by means of the pushbuttons is disabled.

9.1.5. Meter parameterisation mode

To set the meter into the parameterisation mode, the meter cover should be removed. The meter should be in the Reset pushbutton menu so the item "SEt" is displayed on the LCD and the Param pushbutton should be depressed. The Param pushbutton is positioned above the Scroll pushbutton. When the Param pushbutton has been depressed, the left six cursors on the LCD start to blink indicating that the meter is in the parameterisation mode. The meter is now ready to be programmed via the optical port or a serial interface. A security lock (SET2) is opened and editing of all parameters with this protection degree is enabled.

The parameterisation mode is terminated:

- at the end of communication
- when the *time out* is elapsed and communication has not been performed by that time.

Note
The time out, inside which the meter parameterisation via an interface should be performed, is programmable and should be specified when ordering the meter.

9.1.6. Principles of the meter handling and data displaying

Principles of the meter handling and data displaying described in this chapter are shown in the following flow-charts.

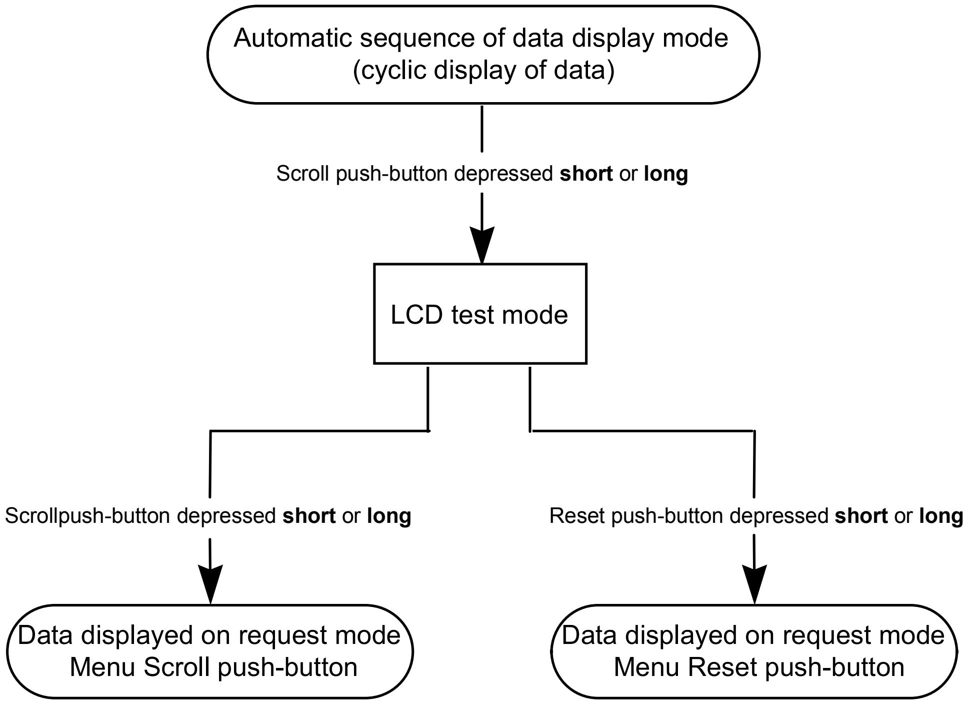


Fig. 9.1 Flow-chart of changing mode of data displaying

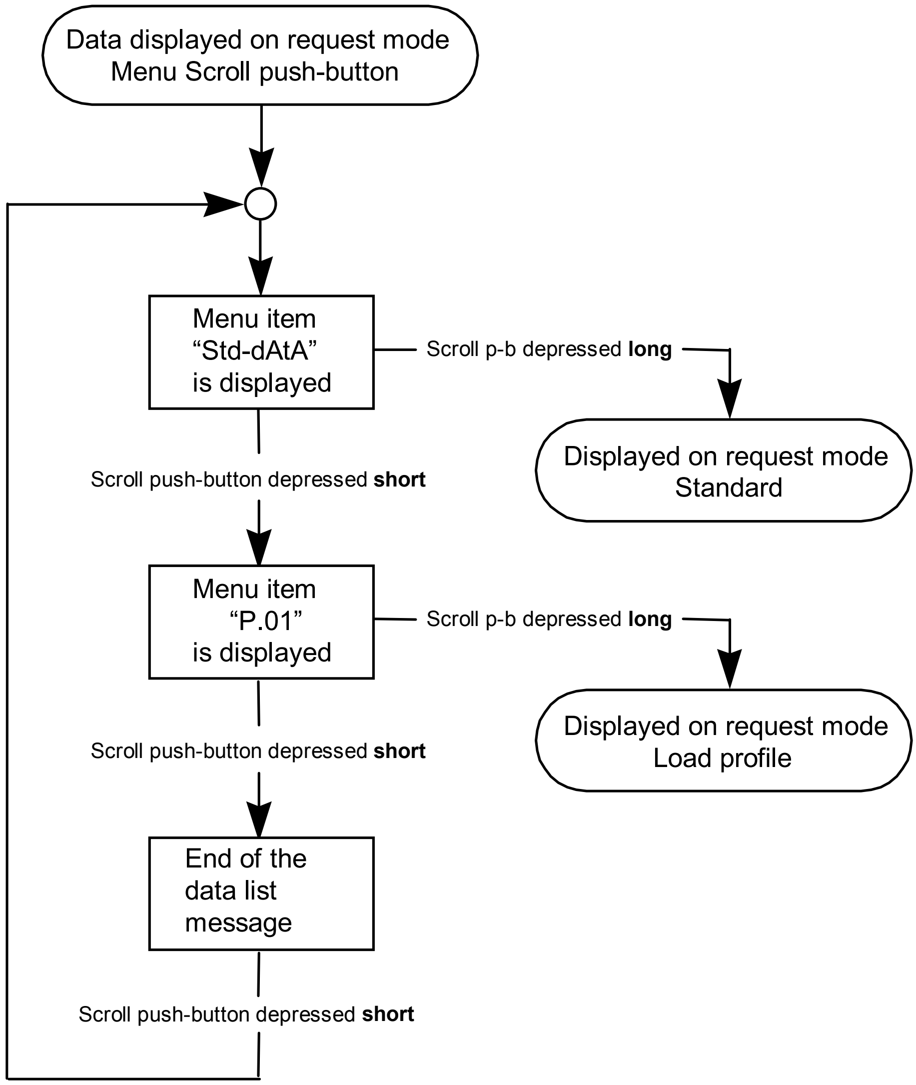


Fig. 9.2: Flow chart of selecting Menu Scroll pushbutton

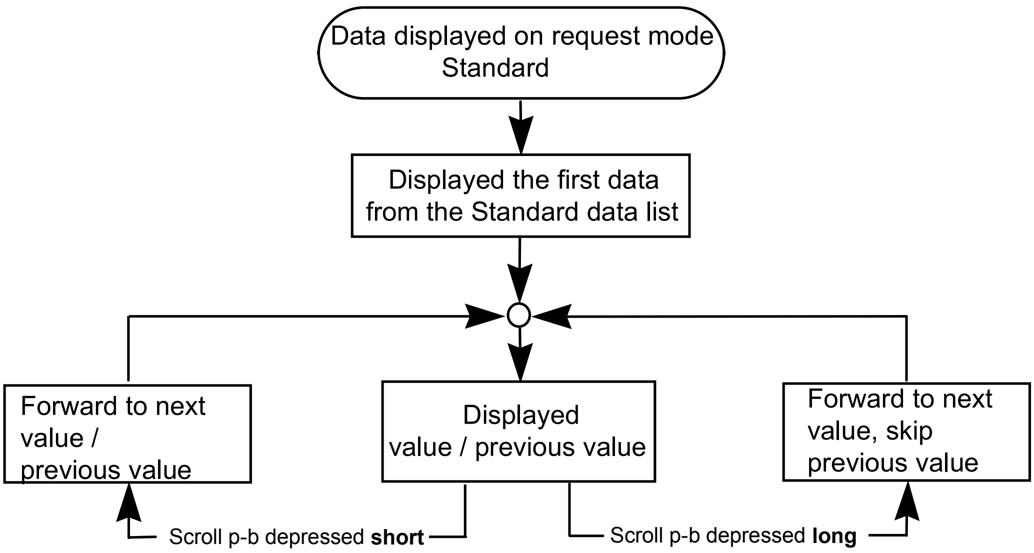


Fig. 9.3: Flow chart of displaying data from the Standard data list

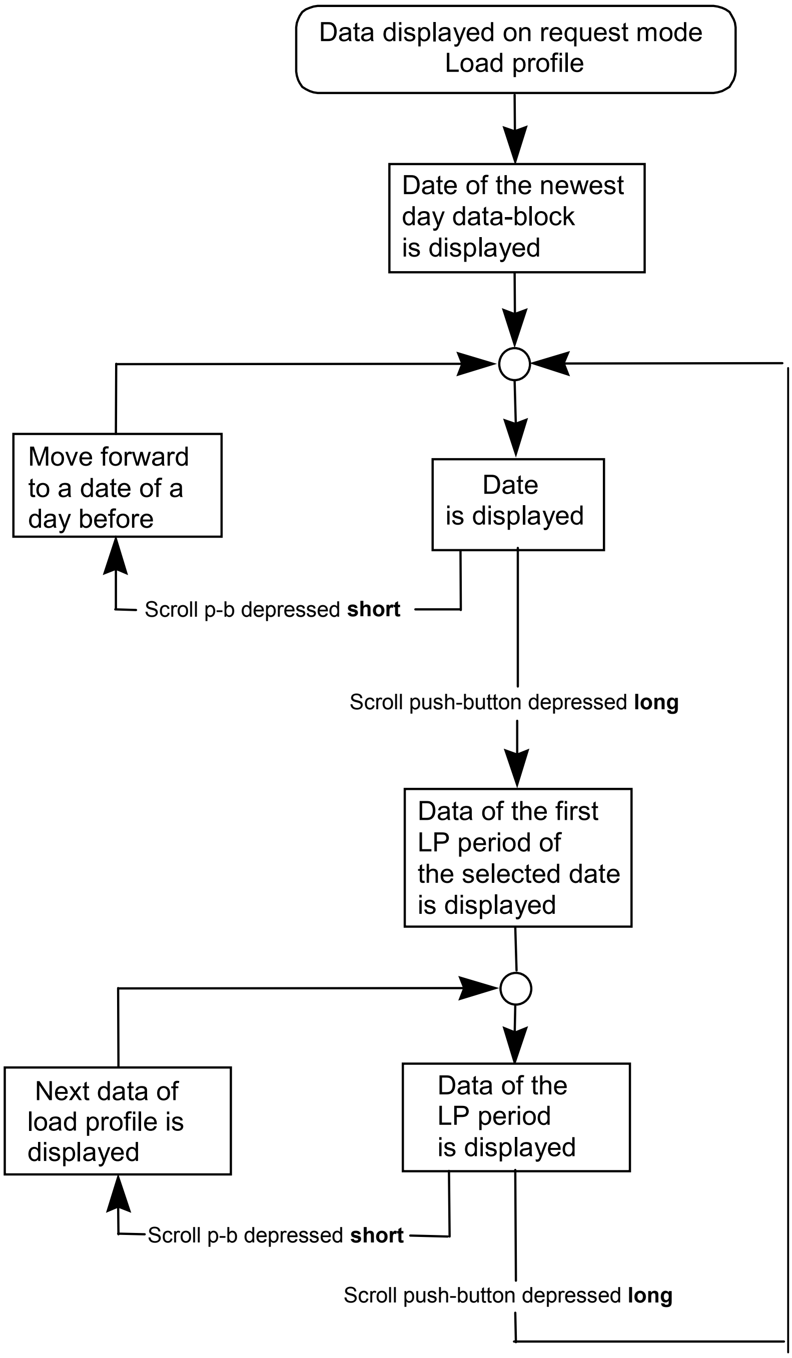


Fig. 9.4: Flow chart of displaying data from the Load profile recorder

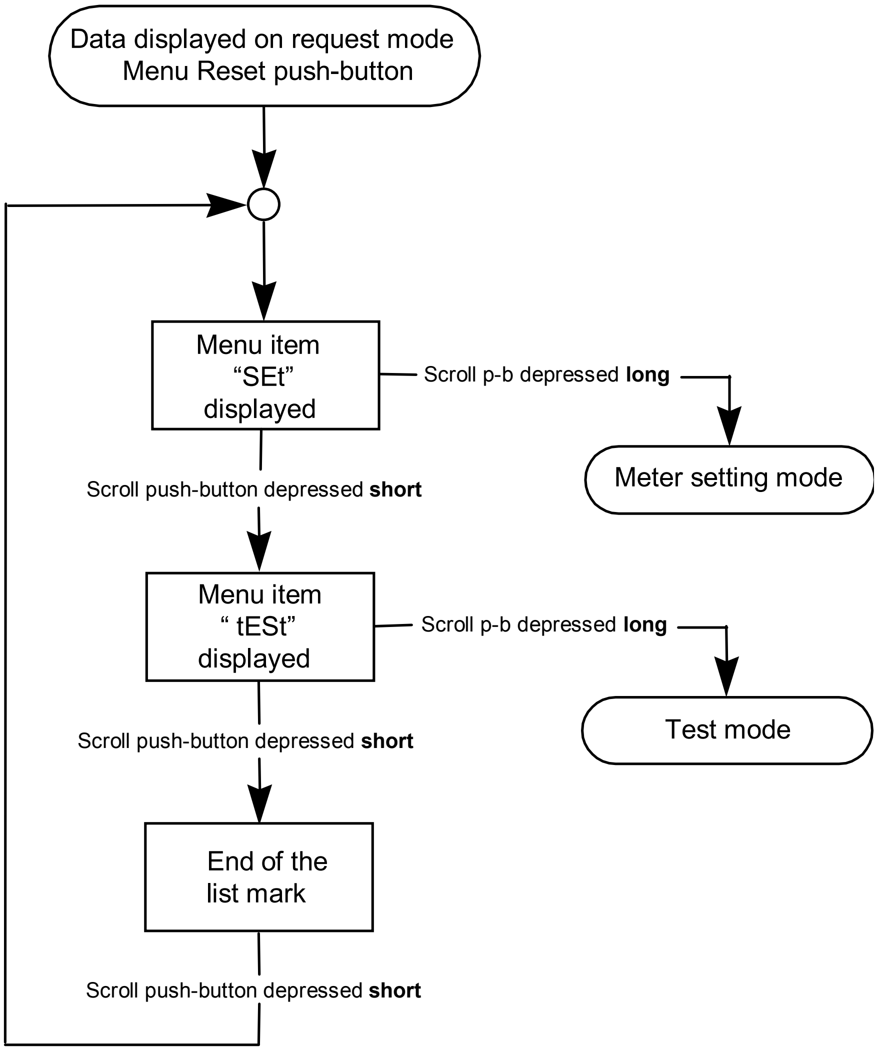


Fig. 9.5: Flow chart of selecting options in the Reset pushbutton menu

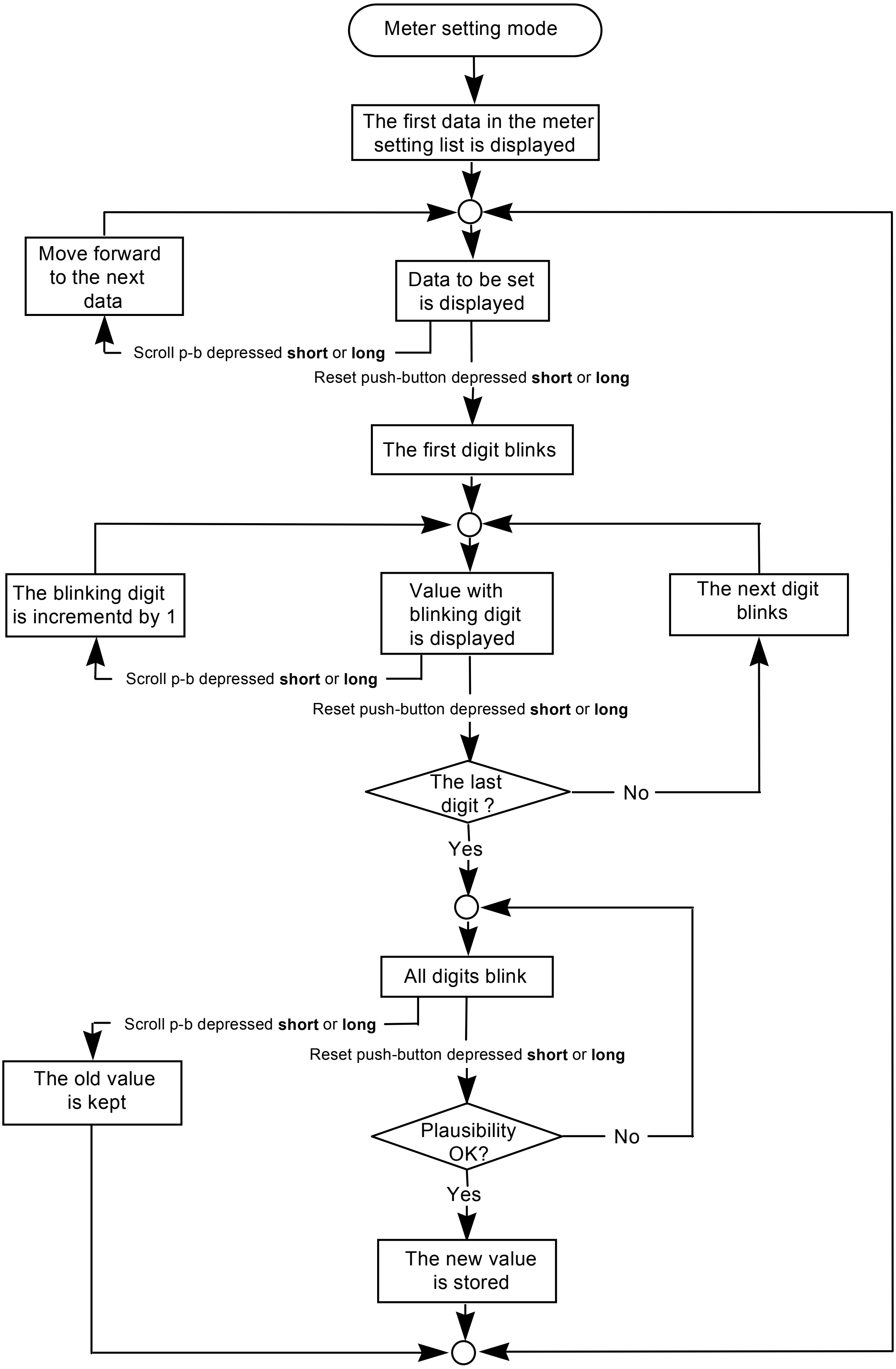


Fig. 9.6: Flow chart of parameters setting with the pushbuttons in the Setting mode

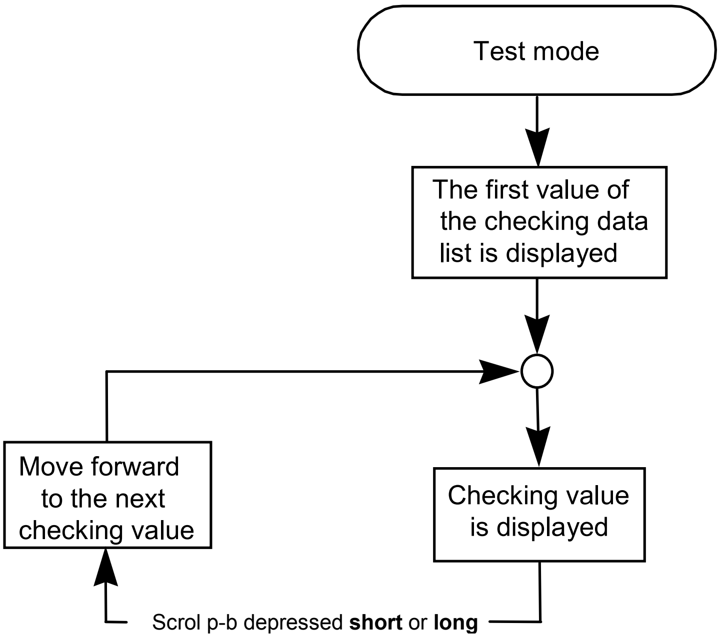


Fig. 9.7: Flow chart of the Test mode

9.1.7. Manual billing reset with Reset pushbutton

When the Reset pushbutton is pressed in the AUTO mode, the meter carries out a billing reset (RR). The following message is displayed on the LCD:

RR done !!!

indicating that the billing reset has been performed.

On request some other message can be displayed instead of this one.

After being depressed the Reset pushbutton is disabled for a certain time in order to prevent another billing reset and data loosing. If the Reset pushbutton is pressed again during the billing reset disabled time span, the billing reset is not performed and the following message is displayed:

RR key block

indicating that the Reset pushbutton is temporally disabled as the billing reset has been performed already.

On request some other message can be displayed instead of this one.

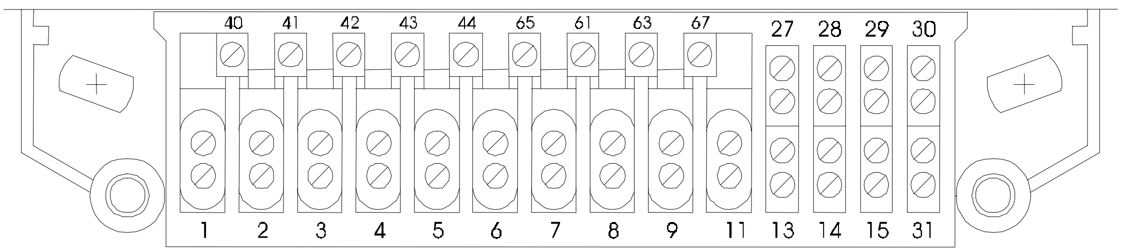
In both cases the LCD returns back into the AUTO mode of data display after 3 s approximately.

10. INPUTS AND OUTPUTS

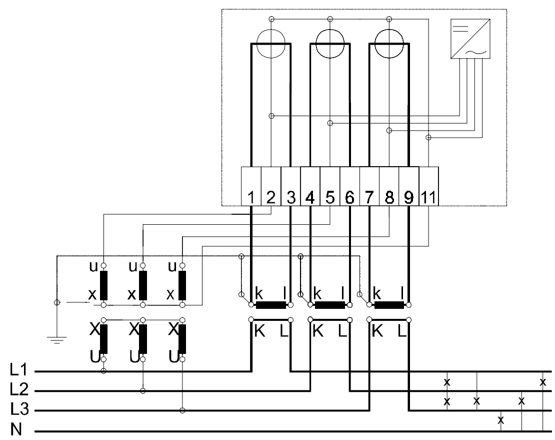
The TE851 meter has 17 auxiliary terminals for input, output, serial communication or external supply. There are two groups of programmable outputs and a group of non-programmable inputs. All groups have a separate ground. Customer can choose up to eight outputs and three inputs.

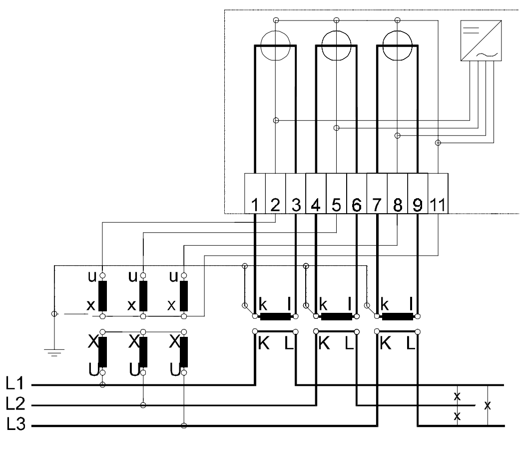
Example:
Auxiliary terminals arrangement in the meter terminal block.

40	**41**	**42**	**43**	**44**	**65**	**61**	**63**	67	**27**	**28**	**29**	30
									13	14	15	31



40	Ground output group 1	**27**	Rx (A line RS485)
41	output 1	**28**	Ground RS232 (B line RS485)
42	output 2	**29**	Tx
43	output 3	30	external/auxiliary supply
44	output 4	13	input 1
65	Ground output group 2	14	input 2
61	output 5	15	Ground tariff inputs
63	output 6	31	external/auxiliary supply
67	MZA		





Note
All inputs and outputs are optional. Therefore, requested inputs and outputs should be specified at meter ordering.

10.1. INPUTS

There are three non-programmable inputs with a common ground. The inputs are performed as semiconductor inputs electrically isolated from the metering part. At 4-wire meters line-to-neutral voltage is applied to the inputs in order to control corresponding meter functions. At 3-wire meters line-to-line voltage is applied to the inputs in order to control corresponding meter functions.

10.1.1. Types of inputs

The following types of inputs are available:

- Inputs for external tariff change-over for energy registration
- Inputs for external tariff change-over for demand registration
- Inputs MRa and MRb for remote billing reset of the meter
- Input MPE for external time synchronisation and/or external triggering of demand period
- Input MZE for external disabling of demand measurement

10.1.1.1. Inputs for external tariff change-over for energy registration

The inputs are used for external change-over of tariffs for energy registration. Voltage applied to a combination of tariff inputs can set one or more tariffs to be valid at same time.

Depending on a requested number of tariffs for energy registration, the meter is equipped with:

- One tariff input for energy **T1**. It enables external change-over of up to 2 tariffs for energy.
- Two tariff inputs for energy **T1** and **T2**. They enable tariff change-over of up to 4 tariffs for energy.
- Three tariff inputs for energy **T1**, **T2**, **T3**. They enable tariff change-over of up to 8 tariffs for energy.

A combination of tariffs can be activated with the external inputs too. In this case a number of tariffs is decreased.

Example

The meter is equipped with two tariff inputs for energy T1 and T2. Energy is to be registered in 3 tariff rates with possibility that 2-nd and 3-rd rates are valid at the same time.

Input T1	***Input T2***	***Active tariff(s)***
0	*0*	*Tariff 1*
0	*1*	*Tariff 2*
1	*0*	*Tariff 3*
1	*1*	*Tariffs 2 and 3*

10.1.1.2. Inputs for external tariff change-over for demand registration

The inputs are used for external changeover of tariffs for demand registration. Voltage applied to a combination of tariff inputs can set one or more tariffs to be valid at same time.

Depending on a number of tariffs for demand registration, the meter is equipped with:

- One tariff input for demand **M1**. It enables external changeover of up to 2 tariffs for demand.
- Two tariff inputs for demand **M1** and **M2**. They enable tariff changeover of up to 4 tariffs for demand.

- Three tariff inputs for demand **M1**, **M2**, **M3**. They enable tariff changeover of up to 8 tariffs for demand.

The tariff changeover for demand registration is identical to tariff changeover for change-over of tariffs for energy (see item 10.1.1.1.).

10.1.1.3. Inputs MRa and MRb for remote billing resetting of the meter

The TE851 meters are equipped with inputs **MRa** and **MRb** on request if remote resetting of the meter at the end of billing periods is required.

For more details on remote resetting of the meter via the inputs MRa and MRb at the end of billing periods see item 6.1.4.

10.1.1.4. Input MPE for external time synchronisation and external triggering of demand periods

The TE851 meters are equipped with the **MPE** input on request if either external triggering of demand periods or synchronisation input for the RTC is required.

A signal on the **MPE** input is a command of the highest priority. It starts a new demand period irrespectively of how much of the current demand period has elapsed or of a command that has been generated by the internal tariff device.

The internal real-time clock can be synchronised by applying a signal to the **MPE** input, too.
Synchronisation is performed in such a way that time of the RTC is shifted to the nearest minute and seconds are reset at the moment when a signal is applied at the MPE input.

Example

a) A signal is applied to the MPE input at hh:50:28. The time is shifted back to hh:50:00.

b) A signal is applied to the MPE input at hh:50:32. The time is shifted forward to hh:51:00.

Note
External synchronisation of the RTC function is set during the meter parameterisation.

10.1.1.5. Input MZE for external disabling of demand measurement

The TE851 meters are equipped with the MZE input if external triggering of demand forgiveness period is requested. Demand is not measured as long as a signal is applied to the **MZE** input. Value 0 is stored in demand registers that relates to time during forgiveness period. At the end of forgiveness period the signal on the **MZE** input should be cancelled and demand is measured again. In case of asynchronous demand measurement the measurement is started at beginning of a new demand period which is started at the moment when the signal on the **MZE** input is cancelled; in case of synchronous demand measurement demand is started to be measured in demand period which is running at the moment when the signal on the **MZE** input is cancelled.

10.1.2. Ground terminals G

The inputs consist of input signal terminals and ground terminal **G**. A ground terminal is common for all inputs.

Note
A number of requested inputs and ground terminals, should be specified when ordering the meter.

10.1.3. Filtering of input signals

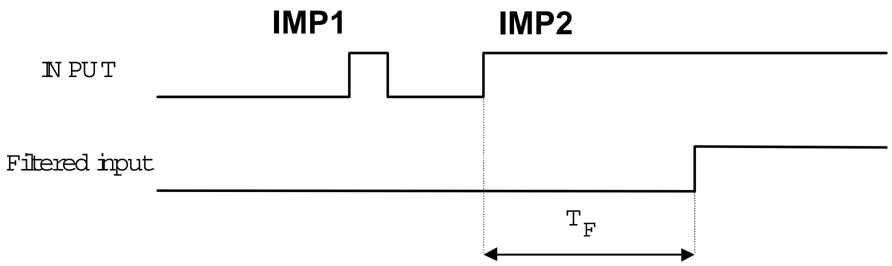
Input control signals can be filtered in order to prevent that short disturbances would be recognised as control signals by the meter and cause false triggering of its functions. Filtering of control signals means that they have to be applied to the corresponding input for a certain time T_F before a command is executed. In this way security of triggering meter functions by external control signal is increased.

Note
If filtering of input signals is required, it should be requested and specified by meter ordering. It is possible to choose the following filtering times T_F:

- 0 - input signal filtering is not performed
- 1 - filtering time T_F = 10 ms
- 2 - filtering time T_F = 30 ms
- 3 - filtering time T_F = 70 ms
- 4 - filtering time T_F = 150 ms.

In case of input signal filtering, signals on all inputs are filtered.

Example of filtering input signals:



IMP1 - 1st impulse which is shorter than filtering time
IMP2 - 2nd impulse which is longer than filtering time
T_F *- filtering time*
Signal IMP1 is shorter than filtering time, therefore it doesn't trigger meter function; signal IMP2 is longer than filtering time, therefore it triggers meter function with delay T_F.

10.2. OUTPUTS

There are two groups of programmable outputs with a separate ground terminal for each functional group. Both groups have four outputs.
The outputs of the TE851 meters are potential-free PHOTO-MOS relays with make contact.

10.2.1. Types of outputs

The TE851 meters can be equipped with the following standard outputs:

- Outputs for remote indication of valid tariff for energy - TA1, TA2 and TA3
- Outputs for remote indication of valid tariff for demand - MA1, MA2 and MA3
- Output for starting demand periods - MP
- Two outputs for indicating energy flow direction - ER1 and ER2
- Two outputs for signalling a billing reset - MRAa and MRAb
- Output for indication of disabled demand measurement - MZA
- Six impulse outputs for indicating energy consumption in a particular quadrant - IA1 through IA6
- Outputs for load control - KP0, KP1 and KP2

On request outputs for remote alarm of different meter status can be built into the meters too.

10.2.1.1. Tariff outputs for energy

Depending on a number of tariffs in which energy is registered by the internal tariff device, the meter can be equipped with 1 to 3 tariff outputs (**TA1**, **TA2** and **TA3**). A make contact is closed at the corresponding tariff output or outputs for remote indication which tariff for energy registration is valid at the moment. If few tariffs for energy are valid at the same time, only tariff of the highest priority is indicated on the tariff outputs. A tariff that is marked 0 has the highest priority, and a tariff that is marked 7 has the lowest.

Example

Energy is registered simultaneously in tariff 1, tariff 5 and tariff 7 by the meter. Make contacts are closed on those terminals of energy tariff outputs which indicate energy registration in the tariff 1, as it has the highest priority. Other two tariffs do not have any influence on the state of the tariff outputs.

Output TA1	Output TA2	Output TA3	Tariff for energy
0	0	0	Tariff 0
1	0	0	Tariff 1
0	1	0	Tariff 2
1	1	0	Tariff 3
0	0	1	Tariff 4
1	0	1	Tariff 5
0	1	1	Tariff 6
1	1	1	Tariff 7

Note
Combination of outputs at which make contacts are closed for remote indication of valid tariff for energy registration should be specified when ordering the meter. Polarity of pulses should be specified too.

10.2.1.2. Tariff outputs for demand

Depending on a number of tariffs in which demand is registered by the internal tariff device, the meter can be equipped with 1 to 3 tariff outputs (**MA1**, **MA2** and **MA3**). Make contacts are closed at the corresponding tariff output or outputs for remote indication which tariff for demand registration is valid at the moment. If few tariffs for demand are valid at the same time, only tariff of the highest priority is indicated on the tariff outputs. A tariff which is marked 0 has the highest priority, and a tariff which is marked 7 has the lowest.

Example

Output MA1	Output MA2	Output MA3	Tariff for demand
0	0	0	Tariff 0
1	0	0	Tariff 1
0	1	0	Tariff 2
1	1	0	Tariff 3
0	0	1	Tariff 4
1	0	1	Tariff 5
0	1	1	Tariff 6
1	1	1	Tariff 7

Note
Combination of outputs at which make contact is closed for remote indication of valid tariff for demand registration should be specified when ordering the meter. Polarity of pulses should be specified too.

10.2.1.3. Output for indication of demand period start

The TE851 meters can be equipped with **MPA** output for indication of start of new demand period. Make contacts are closed for a short time on the **MPA** output at the beginning of each demand period, indicating new demand period. At standard **MPA** output version time span in which contacts are closed is 1% of the demand period.

Note
At meter ordering the following should be specified: time of closed contacts (if they are not the standard version and polarity of pulses.

Depending on a mode of demand period measurement (synchronous or asynchronous) and type of demand period (rolling or fixed), one of the following cases can appear on meter reset:

Mode and type of demand period	Return into the same / another demand period	MPA
Asynchronous, fixed demand period	Irrelevant	0
Asynchronous, fixed demand period	Irrelevant	1
Asynchronous, rolling demand period	Irrelevant	0
Asynchronous, rolling demand period	Irrelevant	1
Synchronous	Irrelevant	0
Synchronous	Same demand period	0
Synchronous	Same demand period + RTC backward*	1
Synchronous	Another demand period	1
Synchronous	Irrelevant	1

* Return of the RTC time backward is considered as return into another demand period. In this case exist a danger that the demand period will be extended.

Which of the cases given in the table will appear is programmed with a corresponding value of a parameter.

10.2.1.4. Outputs for indication of energy flow direction

The TE851 meters can be equipped with **ER1** and **ER2** outputs for remote indication of energy flow direction. One of them has closed contacts and the other has opened contacts. When energy flow direction is changed, contacts on both outputs change their position.

Energy flow direction	Output ER1	Output ER2
Import **A+**	1	0
Export **A-**	0	1

Note
When ordering the meter other position of make contacts on the outputs ER1 and ER2 for indication energy flow direction can be requested.

10.2.1.5. Outputs for indication of billing reset

The TE851 meters can be equipped with **MRA-a** and **MRA-b** outputs for indication of billing reset. Make contacts on one output are closed and on the other are opened. At the moment of billing reset the outputs change their status, i.e. on the first output contacts are opened and on the other are closed. Only simultaneously change of the status on the outputs **MRA-a** and **MRA-b** indicates that billing reset was performed. Change of status on just one of them doesn't indicate billing reset.

In case of power failure contacts are opened on both outputs. When power supply is restored contacts of the first output are closed and on the other are opened at the end of the meter initialisation.

Example

Event	Output MRAa	Output MRAb
End of power failure	**0**	**0**
End of meter initialisation	**1**	**0**
Billing reset	**0**	**1**

Note
When ordering the meter the input at which contacts are closed after the meter initialisation should be specified.

10.2.1.6. Output for indication of disabled demand measurement

The TE851 meters can be equipped with the output **MZA** for remote indication of forgiveness period, i.e. that demand is not measured. During forgiveness period make contacts are closed on the **MZA** output.

Note
When ordering the meter break contacts on the MZA output can be requested for indication of forgiveness period.

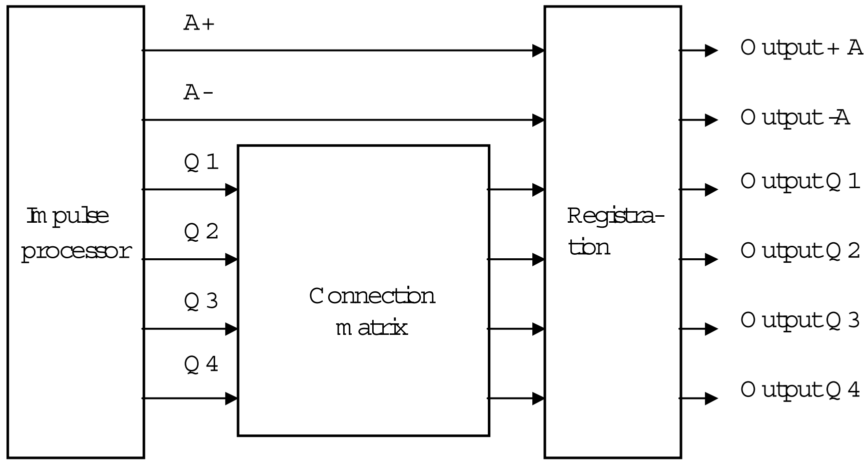
10.2.1.7. Pulse outputs for remote energy reading

The TE851 meters can be equipped with up to six pulse outputs (**IA1** through **IA6**) for remote reading of active energy in two energy flow directions and reactive energy in four quadrants or in combined quadrants. The pulse outputs are potential-free PHOTO-MOS relays with make contact. Pulses can be transferred up to a distance of 1 km. Make contact is closed for 80 ms for each pulse but other values (up to 2400 ms) are available on request.

Output	IA1	IA2	IA3	IA4	IA5	IA6
Energy	A+	A-	Q1	Q2	Q3	Q4

In case of reactive energy registration in combined quadrants one pulse output is built into the meter for each combination of the quadrants.

This is shown in a figure:



Example
A meter that measures +A, -A, Q1+Q2, Q3+Q4 is equipped with the following pulse outputs:

Output	**IA1**	**IA2**	**IA3**	**IA4**
Energy	A+	A-	Q1+Q2	Q3+Q4

Pulse constants **RAW** and **RAB**, i.e. a number of pulses generated per kWh or kvarh depends on voltage and rated current of the meter (see chapter 20). A number of pulses per kWh and kvarh emitted at the pulse outputs can be reduced by dividing them. The divisor of pulse constants can be programmed.

Note
When ordering the meter the following should be specified: required pulse outputs, pulse constant and pulse length (max. 2400 ms). Attention should be paid that selected values of pulse constant and pulse length do not cause overlapping of pulses.

10.2.1.8. Outputs for load control

The TE851 meters with a built-in load limiter are equipped with up to 3 outputs (**KP0**, **KP1** and **KP2)** for load control that the contractual demand is exceeded. Each controller channel have its own output.

Note
When ordering the meter it should be specified if the channels for load control should be provided with physical independent outputs.

10.2.1.9. Status outputs

The TE851 meters can be equipped with meter status outputs for remote warning that a certain meter status has occurred. The meters can be equipped with up to 8 status outputs.

Examples of status outputs

- Output which indicates that at least one phase failed
- Output which indicates that energy in a certain quadrant is registered, e.g. in the 1^{st} quadrant (2^{nd}, 3^{rd}, etc.)
- Output which indicates that energy in combined quadrants is registered, e.g. in the 1^{st} + 2^{nd} quadrant or 3^{rd} + 4^{th} quadrant
- Output which indicates an error on vital data
- Output which indicates that LP recorder is in operation
- etc.

Note
When ordering the meter status outputs (max. 8 outputs) should be specified.

10.3. LED PULSE INDICATORS

The TE851 meters are equipped with two red LEDs on the front plate for meter testing and checking. Blinking rate of the LEDs depend on applied load and meter constant, i.e. a number of pulses per kWh and kvarh. The meter constants of kWh-meter **RLW** and of kvarh-meter **RLB** depending on rated voltage and maximum current of the meter (see chapter 20).

If load is lower than the meter threshold load or there is no load, the LEDs are lit.

10.4. LED POWER INDICATORS

Two green LEDs on the right side of the front plate are used for active and reactive power blocade indication.

11. COMMUNICATION

The TE851 meters can be equipped with up to three different serial asynchronous communication channels: optical port, RS232 and CS (20-mA current loop) interfaces. Communication with the meters is performed in compliance with the **IEC 61107** standard with **Mode C protocol**. The meter operation is not affected during communication.

Note
Required communication channels should be specified when ordering the meters.

11.1. COMMUNICATION CHANNELS

The TE851 meters can communicate via three serial asynchronous communication channels, but only via one at a time. The communication channels are either of high or low priority:

- channel 0 - signal RIN1 (CS - 20 mA current loop) high priority
- channel 1 - signal RIN2 (RS232) high priority
- channel 2 - signal ARxD - optical interface low priority

Hardware of the communication channel defines a maximum possible data transmission rate during communication.

11.1.1. CS interface

The CS interface (20-mA current loop) complies with the DIN 66348 standard and is two-wire communication. It enables communication with maximum transmission rate 19,200 Bauds. The TE851 meters with built-in CS interface are equipped with two auxiliary terminals.

11.1.2. Serial interface RS232/485

The RS232 or RS485 serial interface enables communication with maximum transmission rate 19,200 Bauds. An external device can be connected to the TE851 meters with built-in RS232/485 interface via the meter terminals.

11.1.3. Optical port

All meters are equipped with an infra red optical port for meter programming and data down-loading by means of an optical probe. On the meter front side there is an iron ring to which an optical probe can be attached. The optical port complies with IEC 61107 standard and enables communication with maximum transmission rate 4,800 Bauds.

11.1.4. Priority of communication channels

Communication channels 0 (CS - 20 mA current loop) and 1 (RS232) have the same priority which is higher than the priority of a comm. channel 2 (optical port). This means that communication via the optical port (comm. channel 2) will be immediately interrupted if communication via the CS interface (communication channel 0) or RS232 interface (comm. channel 1) is established. In such case the TE851 meter initialises a complete communication routine and starts to communicate via the corresponding communication channel of the higher priority. During communication via one of the communication channels of the higher priority (e.g. RS232), the other two communication channel (i.e. CS interface and optical port) are disabled till the end of the communication. At the end of the communication, all three communication channels are set in the stand-by mode.

11.2. COMMUNICATION CHARACTERISTICS

Communication with the TE851 meters is performed in compliance with the **IEC 61107** standard with **Mode C protocol**.

Type of communication: Serial asynchronous half-duplex ISO 1177
1 start bit
7 data bits
1 bit parity - odd
1 stop bit
data transfer rate: 300, 600, 1200, 2400, 4800, 9600 or 19200 Baud

11.2.1. Communication protocol

The Mode C protocol (with a password) from the IEC 61107 standard is employed for communication with the meter.

According to the IEC 61107 standard each device must have its own address so that it can be distinguished in the network from other devices. The device address consists of 16 characters and can be programmed as a parameter in the meter parameterisation mode. It is displayed on the LCD as data **0.0.0.**

The following formats of communication packets are used when communicating with the meter:

- **SOH W1 STX** NAME DATA **ETX BCC** ⇒ for programming the meter
- **SOH R1 STX** NAME (ELEMENTS) **ETX BCC** ⇒ for data down-loading from the meter (e.g. data of measurement, tariff change-over schedules, etc.)
- **STX** DATA **ETX BCC** ⇒ the meter response when down-loads data

where:
SOH, **STX** and **ETX** are commands,
W1 is a command to enter data into the meter
R1 is a command to down-load data (except data from the data profile recorder or the logbook)
BCC is a binary check character that verifies the string.

NAME - defines which data is to be reached. It can have the following formats:

- ***name*** ⇒ access to a data which has only one value
- ***name, offset*** ⇒ access to an indexed data (***offset*** is an index of an array)
- ***name(no_elements)*** ⇒ access to ***no_elements*** value of array (from the beginning)
- ***name, offset(no_elements)*** ⇒ access to ***no_elements*** value of array (from ***offset*** onwards)

Each data includes its type and can be formatted by itself. At communication it is therefore possible to state the data name only, and its value is obtained in the correct data format.

DATA - is a block of data that is to be entered or down-loaded. In general a form the data-block is:

- (data1)(data2) ... (data n)
- A data format in a data-block is:
- value(*unit) ⇒ asterisk and unit within the parenthesis can be omitted.

When the meter receives a request for communication it responds with one of the following messages or transmits requested data with a communication package:

- **ACK** - data has been correctly entered or a command has been correctly performed
- **NACK** - communication packet has not been correctly received
- **STX DATA ETX BCC** - communication packet containing requested data
- **STX error ETX BCC** - communication packet containing explanations on errors (something what is not permitted was requested with a communication packet or data can not generate correct value).

The TE851 meter should respond within the Response time. According to the IEC 61107 standard it is defined with minimum and maximum value. Maximum Response time is 1500 msec, while minimum Response time is defined with the third character of the identification message (XXX).

- 3rd character is a capital letter min time = 200 msec ***SCI_RESPONSE_TIME***
- 3rd character is a small letter min time = 20 msec ***SCI_RESPONSE_TIME_SHORT***

Both times can be programmed with the above mentioned parameters.

The communication packet must not exceed 256 characters. If data are down-loaded with a communication packet

SOH R1 STX NAME (ELEMENTS) ETX BCC

and too many data are named to be down-loaded, the meter will transmit as many data as they can be contained in a 256-byte communication packet. The rest of requested data will not be transmitted. To down-load them a new request for data down-loading should be transmitted where new off-set starting with the first data that was not down-loaded should be specified.

Data from the data profile recorder or the logbook are down-loaded with the following communication packet:

- **SOH R3 STX ChannelName ([Start_time End_time]) ETX BCC**

where

R3	is a command to down-load data from a data profile recorder or a logbook
ChannelName	is a name of channel to be read, e.g. **P.98** means the logbook and **P.01** through **P.04** means the data profile recorder
Start_time End_time	are beginning and end of a time span for which data are to be down-loaded.

If data for one day are to be down-loaded, the Start time and the End time should be equal - they are a date of a day for which data should be down-loaded. If data for all load profile periods are to be down-loaded, start and end time should not be defined.

Data from the data profile recorder can be down-loaded either in blocks of 8 channels or per each channel separately.

- **P.01** - data from **data profile channels 0 through 7** are to be down-loaded
- **P.02** - data from **data profile channels 8 through 15** are to be down-loaded
- **P.03** - data from **data profile channels 16 through 23** are to be down-loaded
- **P.04** - data from **data profile channels 24 through 31** are to be down-loaded

A number of channel names available in a meter depends on a number of channels of the built-in data profile recorder (e.g. a meter with a 6-channel load profile recorder has only the **P.01** channel name for it and the **P.98** for the logbook).

In case that data of just one data profile channel are to be downloaded the channel name consist of **P.01** and the channel number (**00** through **31),** separated with coma.

Example
Data from the 11-th channel of the data profile recorder for a period from March 8-th till March 12-ve 1998 should be down-loaded. The following string of commands should be used:

SOH R3 STX P.01,11 ([980308980312]) ETX BCC

Data from the channels 08 through 15 of the data profile recorder for all periods should be down-loaded. The following string of commands should be used:

SOH R3 STX P.02 ( ) ETX BCC

11.2.2. Detection of communication channel and selecting data transfer rate

The TE851 meters can be programmed to communicate at two different data transmission rates by entering corresponding parameters into the registers **C.57.1** and **C.57.2**. The following data transmission rates can be programmed:

Value in register C.57.1 / C.57.2	0	1	2	3	4	5	6	7
Data transfer rate (Baud)	300	600	1,200	2,400	4,800	9,600	19,200	38,400

Data transmission rate set in the **C.57.1** register is used for communication via channels 0 and 1; data transmission rate set in the **C.57.2** register is used for communication via a channel 2.

Note
When programming data transmission rates the maximum one permitted by hardware at a communication channel should be considered, i.e. 19,200 Bauds at the channels 0 and 1 (RS232 and CS interface) and 4,800 Bauds at the channel 2 (optical port). Therefore value 6 should be entered into the register C.57.1 and value 4 should be entered into the register C.57.2. If communication at programmed data transmission rate can not be established with success, a lower data transmission rate for that communication channel should be programmed and the communication repeated.

A communication device sends a request for communication with the meter at data transmission rate 300 Bauds. When the meter receives the opening message for communication, it automatically selects a corresponding data transmission rate in the following manner:

- detects a communication channel via which a request for communication has been received
- transmits back its identification string. Depending on communication channel (0, 1 or 2) via which the request for communication has been received and parameters set in the registers **C.57.1** and **C.57.2**, the meter sets a corresponding parameter "Z" in its identification string.
- the communication device confirms the offered data transmission rate so that in its following message the parameter "Z" is the same as the meter has offered in its identification string.
- the communication between the communication device and the meter will run at data transfer rate selected by the meter
- if the communication device does not confirm the offered data transmission rate, i.e. in its following message the parameter "Z" has different value form the one offered by the TE851 meter in its identification string, the communication at data transmission rate 300 bauds is continued.

This procedure of selecting data transmission rate complies with the requirements of the IEC 61107 standard.

11.3. TIME-OUT AT COMMUNICATION

Whenever communication with the meter has been established and no message was received by elapsed Time-out, the meter returns back into data displaying in the AUTO mode. In such case communication can be restored only by the opening sequence for communication of the Mode C protocol.

11.4. DATA DOWN-LOADING

Data down-loading is performed via one of three communication channels. At readout the meter mediates all data which are defined in the **DRO** (data readout) sequence together with their previous values if they are selected. Data readout is performed with a standard command of the Mode C protocol:

ACK, 0, Z, 0, CR, LF

After reception of this command, the TE851 meter transmits values of all data which are stated in the **DRO** sequence. In case of data for which previous values (values for previous months) exist, it can be requested either that only a value for current month is transmitted or a value of a current month + a block of previous values are transmitted by setting 0 or 1 respectively on the bit15 in the sequence. The format of one variable is as follows:

[variable_name [.index_of previous_value]](value [*units])CRLF

The index of previous value and units can be omitted by setting 0 at the bit1 and bit0 of the system parameter in the register **N_ 233**, respectively.

- The name is transmitted when the system parameter in the register **N_ 233** has bit1 = 1.
- Units are transmitted when the system variable **N_233** has bit0 = 1.

12. LOGBOOK

The TE851 meters record certain types of events in a logbook. Record of each event is accompanied with date and time (a time stamp) of its occurrence. This enables subsequent analysis of the meter operation, survey of interventions into the meter as well as reconstruction of errors. For security reasons data recorded in the logbook can not be deleted.

The logbook has 255 registers organised as a ring buffer so that the latest events are always available for survey (first in, first out data registration technique). Depending on the TE851 meter version a number of registers of the logbook can be increased or decreased on request.

Events are recorded in the data format:
(**date and time, event**)

- date and time are recorded in the data format **yy-mm-dd hh:mm** (e.g. 97-08-20 08:26)
- The event is defined with a certain test (e.g. performed readout is marked **DRO;** short-term failure causes a watchdog reset, which is listed as a **WDOG reset**, long-term failure is marked as **PWDN reset** when voltage is restored**.**

The following events can be recorded in the logbook:

Event	Normal listing
Meter reset triggered by the watchdog circuit	WDOG reset
Meter reset caused by power shortage	Power Down Reset
Meter reset caused by restoration of power supply	Power Up Reset
Parameter setting via communication channel	Par comm.
Setting with pushbuttons	Set pushbutton board
Parameter setting with pushbuttons	Par. pushbutton board
Setting time of RTC	Set RTC
Master device reset	Master Device Reset
Initialisation of LP recorder	Recorder init.
Initialisation of billing period	Maximum Demand Reset
Readout of DRO sequence	DRO
CPU exception error	CPU exc. Error
Invalid event	Error
No event (the logbook register is empty)	Error

13. METER RESETS

The following resets can be performed: at the end of a billing period (triggered by internal tariff device, by pressing the Reset pushbutton or triggered externally via inputs **MRa** and **MRb**), at power-up (at restoration of power supply after power shortage), at intervention of the watchdog circuit, at master reset of the meter, initialisation of the previous values registers and reset of the data profile recorder.

13.1. POWER-UP RESET

The power-up reset (PWUP reset) is performed when power supply is restored after power shortage or the meter is connected to the network for the first time. At the power-up reset the meter is returned into the state in which it was before its power supply was terminated. If power-up reset has been performed, it is indicated with value 0 in the register **C.54.1**.

The following actions are performed on power-up reset:

- Hardware initialisation
- Initialisation of system variables
- Pause (Start Up Delay) is started during which the capacitor is recharged so that procedure at power failure can be performed
- All measuring registers and other vital data are regenerated into the state as before the power failure
- The data profile recorder initialises registers as empty of all LP periods which are covered with power shortage time
- The Power Down Resets counter is incremented (data in the register C.7.0)

PWUP reset is performed also after the meter parameterisation or setting either via communication channels or with pushbuttons to avoid non-permitted states. Namely, the meter parameters are changed both with meter parameterisation and setting. During both procedures the meter performs all measurements and calculations with old parameters. Therefore the watchdog circuit automatically resets the meter after the meter parameterisation and setting so that measurements and calculations with old parameters are terminated and the new one are started employing the new parameters.

13.2. WATCHDOG RESET

Watchdog (WDOG) reset is performed in the following cases:

- If the microprocessor has begun to perform non-permitted instructions due to disturbances.
- If the program running in the microprocessor failed due to disturbance.
- At short-term power shortages when the capacitor voltage has not fallen under a certain value.
- After the meter parameterisation or setting.

WDOG reset has completely the same task and effect as Power Up reset. The only difference is that Start Up delay is omitted and the WDOG resets counter is incremented (data in the register **C.50.0**). If WDOG reset has been performed, it is indicated with value 1 in the register **C.54.1**.

13.3. MASTER DEVICE RESET

WARNING!
The master reset causes loss of all metering data and meter settings!

The master reset is performed when the meter is to be used with new software. In such case all existing parameters, settings and metering data should be deleted, i.e. all registers are deleted and initialised (measuring data, statuses, parameter settings, counters of events, previous billing periods data of the load profile recorder):

- Values of vital data are set to 0
- Statuses of vital data are deleted
- Reset counters are reset
- Elapsed time counter of the RTC supplied by the Li-battery is reset
- Counters of phase voltage failures are reset
- Counters of errors in primary and secondary copies are reset
- The main status for vital data is set to a "valid" state"
- Permanent statuses are deleted and set to default values
- All measuring data registers of previous billing periods are deleted and marked as empty
- All data in the load profile recorder are deleted and the recorder is initialised
- Time of the RTC does not change
- The logbook is deleted and the master reset is registered

It is recommended to set exact time and date in the real-time clock before the master reset is executed. The master reset is executed via communication channels by sending a corresponding command. This command is protected with an 8-character password or with some other protection measure (e.g. Param key) requested by the customer to avoid fraud. For more details about see chapter 18: Anti-fraud protection.

Note
When ordering the meter protection measure against misuse of the master reset command should be specified.

When the master reset is performed the following message is displayed on the LCD:

MAStEr rESEt

At the same time master reset as well as date and time are recorded as an event into the logbook.

13.4. INITIALISATION OF REGISTERS OF PREVIOUS BILLING PERIODS

WARNING!
The initialisation of previous billing periods causes loss of all metering data of the completed billing periods!

The initialisation of registers of the previous billing periods is performed when metering data of the previous billing are to be deleted. The cumulative metering values and values registered in a current billing period are not deleted and all meter parameter settings, statuses, etc. are kept. The counter of previous billing periods (register **0.1.0**) and the counter of available billing periods stored in the memory (register **0.1.1**) are reset, the other counters keep their value.

The initialisation of registers for previous billing periods is executed via communication channels by sending a corresponding command. This command is protected with an 8-character password or with some other protection measure (e.g. Param key) requested by the customer to avoid fraud. For more details see chapter 18: Anti-fraud protection.

Note
When ordering the meter protection measure against misuse of the initialisation of registers of previous billing periods command should be specified.

13.5. RESET OF DATA PROFILE RECORDER

WARNING!
The reset of data profile recorder causes loss of all profile data!

The reset of data profile recorder is performed when profile data are to be deleted.

The reset of data profile recorder is executed via communication channels by sending a corresponding command. This command is protected with an 8-character password or with some other protection measure (e.g. Param key) requested by the customer to avoid fraud. For more details see chapter 18: Anti-fraud protection.

Note
When ordering the meter protection measure against misuse of the reset of data profile recorder command should be specified.

13.6. BILLING RESET

The billing reset is performed at the end of each billing period in order to store metering data of the just terminated billing period and to initialise registers of a current billing period. For more details see chapter 6: Billing reset.

14. REAL-TIME CLOCK

The TE851 meters are equipped with a real-time clock (RTC). It is controlled with a quartz crystal but has also an input for synchronisation with 50 Hz frequency and an input for time correction by means of the **MPE** signal applied to the meter input (see item 10.1.1.4).

The real-time clock is an annual clock programmed by the year 2099 and will not be affected with the year 2000. It is used for:

- timing demand and load profile periods
- time-of-use registration
- performing billing resets
- generating time stamps of events recorded in the logbook
- shifting time from standard time to time used during the day-light saving period
- measurement of time how long the Scroll pushbutton was depressed so that corresponding meter mode is selected, time of power shortage period, forgiveness period, disabled Reset pushbutton period, time span in which demand is not calculated for the 3-point controller of load limiter (if built-in), filtering signals at inputs, etc.

14.1. RTC VERSIONS

The RTC version is defined with a parameter set in the register **C.59.0** during meter configuration. The following RTC versions are available:

Parameter C.59.0	RTC version
0	RTC controlled by quartz crystal
1	RTC synchronised with 50 Hz frequency
2	RTC controlled by quartz crystal and **MPE** correction
3	RTC synchronised with 50 Hz frequency and **MPE** correction

14.1.1. Crystal controlled RTC

The quartz crystal of the RTC is digitally trimmed during meters manufacturing so that it is tuned to exact frequency 20 MHz. A value of the trimming constant is in a range from 0 to 255 and can be displayed on the LCD as a parameter **C.55.9**.

The crystal controlled RTC complies with the IEC 61038 standard. Its accuracy is ±3 min/year at room temperature; the error is cumulative.

14.1.2. RTC synchronisation with 50 Hz frequency

The RTC is automatically synchronised with 50 Hz frequency if the corresponding input is enabled (2 is set in the register **C.59.0**) and the 50 Hz frequency is fed to it, otherwise the RTC is controlled with a quartz crystal. Such a design of the RTC permits that it runs on 50 Hz frequency and switch to quartz crystal control automatically in case of power failure. When the power supply is restored, the RTC switches back to 50 Hz synchronisation.

Accuracy of the RTC synchronised with 50 Hz frequency depends on its accuracy. In countries where frequency is strictly controlled long-term accuracy of the RTC is ±30 sec; the error is not cumulative.

14.1.3. RTC time correction by MPE signal

Both RTC controlled by quartz crystal and RTC synchronised with 50 Hz frequency can be adjusted by applying a signal to the MPE input if such an option is enabled by setting value 1 or 3 in the register **C.59.0**. The MPE signal rounds current the RTC time hh:mm:ss to a minute (seconds are reset to 00).

14.2. BACK-UP POWER SUPPLY OF THE RTC

The RTC clock is backed-up with a super capacitor or on request with a super capacitor and a Li-battery. Capacity of the super capacitor enables 250 hours operation reserve of the RTC. The super capacitor is recharged to full capacity within 1 hour after being exhausted. Capacity of the Li-battery enables 2 year operation of the RTC. Its shelf-life is 10 years. In case of power shortage lasting up to 100 hours, the RTC is backed-up with the super capacitor. If power shortage is lasting longer than 100 hours, the Li-battery starts to back-up the RTC.

The Li-battery is located in the meter terminal block, so that it can be replaced easily. There is a counter of elapsed time during which the RTC was backed-up with the Li-battery and an indicator that it is time to replace the Li-battery before it becomes flat. The indicator is a cursor on the LCD that blinks if the Li-battery is to be replaced. The meter can be also be equipped with and auxiliary output for remote alarming that the Li-battery is to be replaced.

14.3. DAY IN WEEK

A day in week is set automatically by the RTC regarding the entered date. When displayed or down-loaded the days in week are coded with numbers 1, 2, ... 7 in sequence starting with the first day in week. Each day in week can be defined as the first one (coded 1) and the others follow in the increasing sequence, e.g.:

- **week starts with Sunday**
  Sunday = 1 ⇒ Monday = 2, Tuesday = 3, ... Saturday = 7
- **week starts with Monday**
  Monday = 1 ⇒ Tuesday = 2, Wednesday = 3, ... Sunday = 7

etc.

14.4. DATE AND TIME FORMAT

Date and time, date or time of the RTC can be displayed and down-loaded.

EDIS code	Name of quantity	Data displayed on LCD	Data format in DRO
0.9.1	Time in the RTC	hh:mm:ss	hh:mm:ss
0.9.2	Date in the RTC	d YY.MM.DD	d YY-MM-DD
0.9.4	Date and time in the RTC	not displayed	YY-MM-DD hh:mm:ss

where
hh - hour (00 through 23)
mm - minute (00 through 59)
ss - second (00 through 59)
d - day in week (1 through 7)
YY - year (the last two digits of the year: 00 through 99)
MM - month (01 through 12)
DD - day in month (01 through 31)

Time and date in the RTC can be set either with the pushbuttons or via a communication interface.

Note
When ordering a meter the following should be specified:

- **RTC version (quartz controlled or synchronised with 50 Hz frequency)**
- **RTC time correction with SMP signal**
- ***RTC back-up (super capacitor or Li-battery + super capacitor)***
- **whether remote alarming that Li-battery is low is required**
- ***the first day in week***

14.5. VERIFICATION OF TIME VALIDITY

The default date and time are entered into the microcomputer when the meter is configured. The default date set by the manufacturer is January 1-st, 1998; the default time is 00:00:00. The default date is the oldest one in the device and is used for verification validity of the RTC date as well as for default setting of date and time.

The time validity is verified at each reset of the microcomputer (i.e. WDOG reset, PWDN reset and billing reset). At the same time status of eventual error is stated and a corresponding action for eliminating the error is activated. The TE851 meters have two statuses of the RTC date and time:

- **Operation status** (**N_133**) - is a status that occurs at testing the RTC time after the microcomputer reset. It is the most recent information on the RTC status.
- **History status** (**N_134**) - permanently stores the status of the RTC errors irrespective of how many resets back they occurred. This status is set to OK only at a **regular setting of the RTC time.**

14.6. TYPES OF RTC TIME SETTING

The RTC time can be set by default date and time stored in the microcomputer or by entering current time either by the pushbuttons or via communication interface.

14.6.1. Default date and time setting

Default date and time setting is performed when a request for setting of date and time occurred due to an error of the RTC. This procedure is performed automatically by the microcomputer and is caused by an external disturbance. It is performed in order to eliminate cause of error and its consequence, however, from that moment onwards the RTC date and time will not be correct anymore. When this routine is activated the following is performed:

- default date and time are set in the RTC
- status standard time / day-light saving period is set
- a compensation constant stored in the EEPROM is entered
- a check value is entered
- history status and operation status indicate error that caused setting default date and time in the RTC

14.6.2. Regular date and time setting

Regular date and time setting is performed when date and time are entered manually by the pushbuttons or via a communication interface. With this action exact time and date are set in the RTC therefore the following is performed:

- exact time and date are set in the RTC
- status standard time / day-light saving period is set
- a compensation constant stored in the EEPROM is entered
- a check value is entered
- history status and operation status contain a reason for error that caused this action
- OK is set in the history status and operation status

The check value is used for testing that non-real value is stored in the RTC registers for time and date (e.g. value 73 for minutes or seconds, value 25 for months, value 9 for day in week, etc.). In such cases the default time and date are set automatically. If date and/or time are not correct but their values are real they will not be corrected.

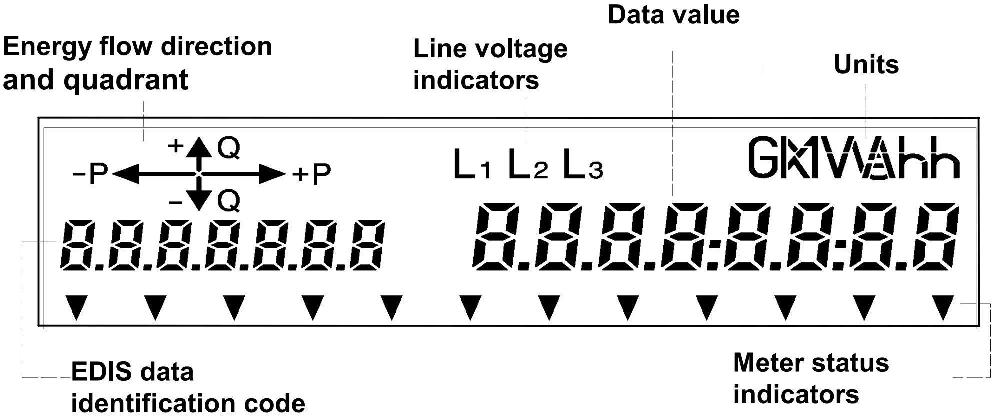
15. DISPLAY AND METER NAME PLATE

The TE851 meters is equipped with custom design LCD in compliance with the VDEW requirements. LCD is menu driven and is handling by pressing one pushbutton at time (one-hand handling) as it is required by the VDEW Requirements. It has back-light illumination for easy data reading at metering place with bad light condition. The LCD is illuminated when the Scroll pushbutton is depressed for less than 2 seconds. The LCD illumination is switched-off after three minutes if no pushbutton was pressed at that time.

15.1. VDEW CUSTOM DESIGNED LCD

The VDEW custom designed LCD has large figures easy for reading as well as graphical symbols and enunciators easy to be understood.

- **CUSTOM DESIGNED LCD IN COMPLIANCE WITH VDEW 2.0 REQUIREMENTS**



15.1.1. Data value display

Eight 7-segment digits on the right side of the LDC are used to display data value. Colons and points are displayed too.

15.1.2. Data identification code

Displayed data is identified with EDIS code (DIN 43863-3) displayed on seven 7-sement characters on the left side of the LCD. If previous data is displayed, code of a previous billing period is displayed too. Parts of data identification code are separated by dots.

15.1.3. Energy flow direction and quadrant indicator

In the left top corner there is a graphical symbol of active energy flow direction and quadrant of reactive energy.

Symbol VDEW 2.0	Energy flow direction and quadrant
→	Active energy import
←	Active energy export
↑→	Reactive energy 1-st quadrant
←↑	Reactive energy 2-nd quadrant
←↓	Reactive energy 3-rd quadrant
↓→	Reactive energy 4-th quadrant

Displayed symbols indicate direction of active energy and reactive energy in the particular quadrant. Blinking symbols indicate direction of active energy and reactive energy in the particular quadrant but their value is bellow the meter threshold **0.002xIb**, therefore the meter does not register it.

15.1.4. Line voltage indicator

A line voltage indicator indicates that a particular line-to-neutral voltage is applied or not applied to the voltage terminal. The line voltage indicators consist of three segments, for each line one. When all three line-to-neutral voltages are applied to the meter terminal, all three segments are displayed

L1 L2 L3

Not displayed symbol(s) **L1**, **L2** or **L3** indicate that the corresponding line has failed. When the line voltage indicator **L1 L2 L3** is blinking, it indicates reversed phase sequence.

15.1.5. Units

Unit of displayed quantity is displayed in the right top corner of the LCD. The following units can be displayed:

W, kW, MW, GW, Wh, kWh, MWh, Gwh, V, A, kV, kA, VA, kVA, MVA, GVA, Vah, kVAh, MVAh, GVAh, var, kvar, Mvar, varh, kvarh, Mvarh, Gvarh, h.

15.1.6. Meter status indicators

The meter status indicators are in the bottom line of the LCD. Up to 12 triangular-form cursors can be used for different meter status indicators. Meaning of each indicator is printed on the meter name plate bellow the cursor.

Standard meter status indicators are:

- **T1, T2, … ,T8 /** lit **/** **-** valid tariff for energy
- **M1, M2, … ,M8 /** lit **/** **-** valid tariff for energy
- **ERR /** blinking **/** **-** error on vital data
- **DRO /** lit **/** - data are being down-loaded
- **SET** /lit/ - indication that the pushbutton-lock for setting is unlocked
- **PAR** /lit/ - indication that a pushbutton-lock for parameterisation is unlocked
- **Li-bat /** blinking **/** **-** indication that Li-battery is low
- **6 left cursors /blink/** **-** indication that the meter is in setting or parameterisation mode

Note
Required indicators of meter statuses should be specified when ordering the meter.

15.2. LCD MODES

The LCD can be in one of the following modes:

- Start logo
- AUTO mode of data display
- Test of the LCD mode
- Data displayed on request mode
- Special messages

Data displayed in each of the LCD modes can be set by parameterisation.

15.2.1. AUTO mode of data display

In AUTO mode data from the Standard Display Sequence are cyclically displayed on the LCD. Each data is displayed for 10 s approximately, but on request data display time can be shorter.

15.2.2. Test of the LCD mode

The LCD is tested when in the AUTO mode the Scroll pushbutton is pressed a second time for less than 2 seconds. In the LCD test mode two patterns are displayed alternatively: the first one that the LCD test is performed and the second one with all characters displayed.

15.2.3. Data displayed on request mode

When the Scroll pushbutton is depressed for less than 2 seconds at the end of the LCD test, the meter is set into the Data displayed on request mode. With each depress of the Scroll pushbutton next data is displayed. If the Scroll pushbutton is hold depressed more than 2 seconds, the first data from the next data-block is displayed; if it is hold depressed less than 2 seconds, the next data from the same data-block is displayed, except if it was the last one in the data-block. If the Scroll pushbutton was not pressed for more than two demand periods, the meter returns back into the AUTO mode (for more details see items 9.1.3.1, 9.1.3.2 and 9.1.6).

15.2.4. Meter parameterisation mode

The meter is set into the parameterisation mode by pressing the Param pushbutton. The parameterisation sequence is displayed on the LCD. The meter is parameterised by pressing the pushbuttons Scroll and Reset.

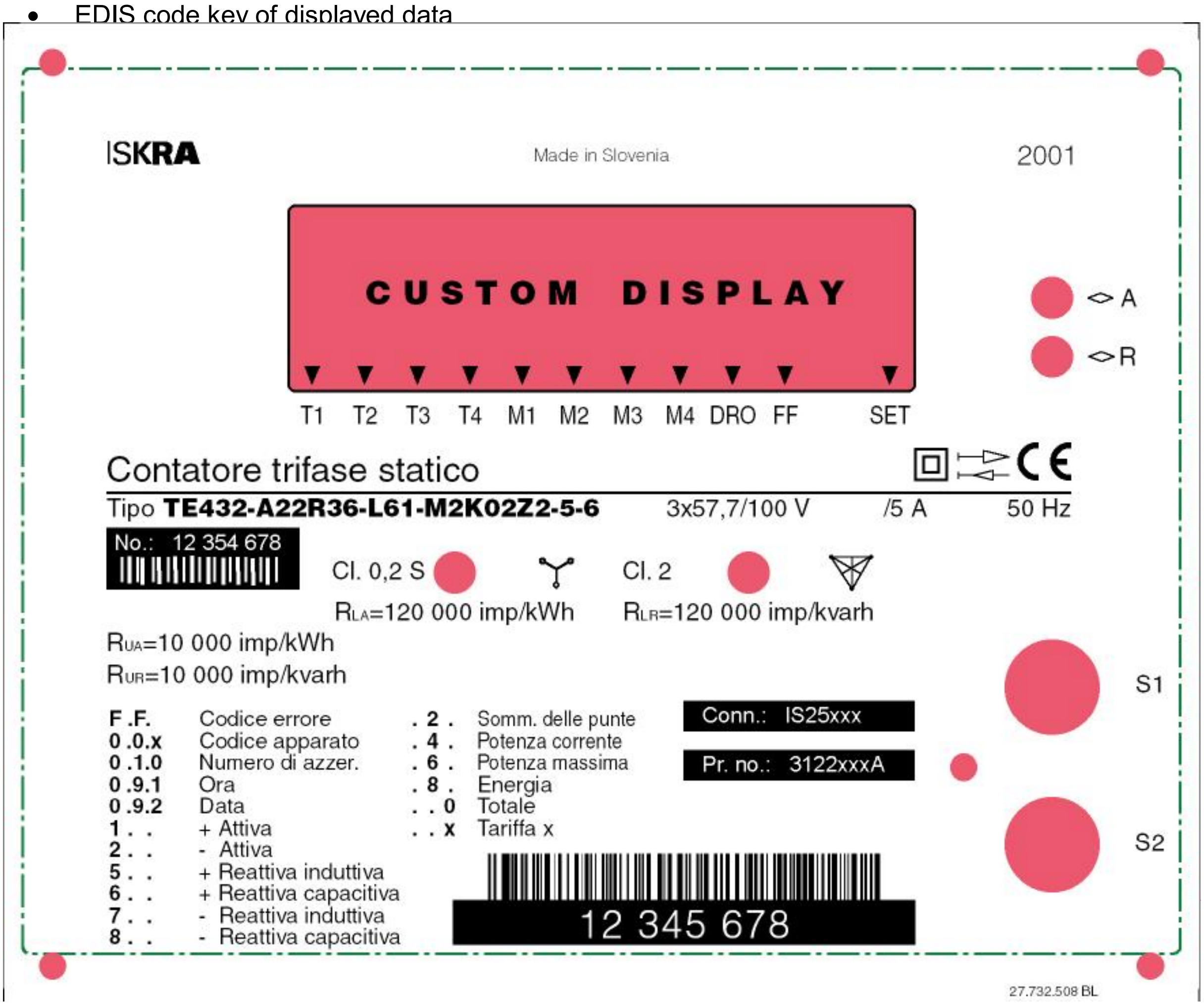
15.2.5. Meter setting mode

The meter is set into the setting mode by pressing the Reset pushbutton after the LCD test has been performed. The setting sequence is displayed on the LCD. The settings can be performed by successive pressing the Reset and Scroll pushbuttons or with a communication via the optical port.

15.3. METER NAME PLATE

The following data are printed on the meter name plate:

- Meter serial number
- Ownership number
- Owner’s name or logo (on request)
- Bar code (on request)
- Meter type and version designation
- Meter accuracy (in compliance with IEC 60687 for kWh-meter and IEC 61268 for kvarh-meter)
- Year of manufacturing
- Meter approval mark
- Rated voltage
- Rated frequency
- Base and maximum currents
- Pulse constants at meter testing LEDs and pulse outputs
- EDIS code key of displayed data



16. METER SETTING, PARAMETERISATION AND CONFIGURATION

The TE851 meters are custom designed. This means that an electric utility can specify meter functions of their choice according to their needs and also to modify them when their needs are changed. Subsequent meter modification is limited with the existing hardware of the meters. Therefore the TE851 meters has three meter programming modes: setting, parameterisation and configuration. In order to avoid meter tampering and fraud each programming mode has corresponding level of authorisation level. The lowest authorisation level is required for meter setting, the highest level is for meter configuration. A meter is parameterisation only by the manufacturer in compliance with electric utility meter specification.

Programming can be done manually by means of pushbuttons or via communication interface with a hand-held unit or PC and software MeterView. The MeterView software runs in Windows 95 or later versions.

16.1. METER SETTING

Meter setting is a programming mode that can be performed only by an authorised person (i.e. by an operator of electric utility). Meter parameters defined with the **Setting sequence** in the **Meter parameterisatio mode** can be programmed or edited in the **Meter setting mode**.

Meter parameters from the **Setting sequence** can be programmed or edited in two ways:

- with pushbuttons
- via communication interface

16.1.1. Manual meter setting with pushbuttons

The Scroll and Reset pushbuttons are used for manual meter setting. For more details on manual meter setting see Chapter 9: Meter handling and data displaying.

The Reset pushbutton is sealed or locked by electric utility, therefore manual meter setting can be performed only when the seal is removed or a padlock is unlocked.

16.1.2. Meter setting via communication interface

It is performed with a portable PC and MeterView software from Iskraemeco or with a hand-held terminal. The meter setting can be performed via the following communication interfaces: optical interface, CS interface or RS232 interface.
The access to the parameters is protected with a password and/or a special algorithm for programming meter parameters to avoid tampering.

16.1.3. Typical parameters programmed in the meter setting mode

Parameters that are most frequently modified by an electric utility are entered into the Setting sequence. Only parameters that are defined in the Setting sequence can be modified in the meter setting mode.

Note
Parameters that are to be programmed and edited in the meter setting mode should be specified when ordering the meter.

Typical parameters that are programmed in the meter setting mode are tariff change-over program, holidays, date of billing reset, etc. These data are entered into the meter by MeterView software (for more details see MeterView user manual)
Other parameters programmed in the meter setting mode are given in the table bellow.

EDIS	Meter parameter
N_115	Time after which the LCD returns back into AUTO mode if no pushbutton was pressed
N_116	Time-out at communication
C.55.10	Time of the LCD illumination after pressing the Scroll pushbutton
0.4.2	Current transformer ratio
C.59.3	Indexing mode of previous values 0/1 linear indexing / circular indexing
C.59.4	Delays of tariff change-over and billing reset b0-tariff, b1-billing
C.58.2	Identification text for IDENT-X communication
C.58.1	Identification text - type
0.0.0	Device address 0
0.0.1	Device address 1
C.1.0	Factory number 0
0.2.0	Factory number 1
C.57.1	Baud rate for primary communication interface
C.57.2	Baud rate for secondary communication interface
C.58.3	Password text
C.58.4	Password 2 text
N_336	Constant of the microcomputer (MC); Total, active
N_337	Constant of the microcomputer (MC); Total, reactive
C.59.0	External synchronisation with a network frequency 0/1 - yes/no
C.55.1	Time of disabling the Reset pushbutton (min)
0.9.4	Current date and time in the RTC YYMMDDdhhmmss d- designation for a day in week
0.9.2	Current date in the RTC dYYMMDD
0.9.1	Current time in the RTC hhmmss
C.55.9	Compensation of quartz crystal frequency

Some of them are programmed by means of the MeterView software, the other are included in the Setting sequence.

16.2. METER PARAMETERISATION

Meter parameterisation can be performed only via communication interface. Access to the meter parameters that can be programmed or edited in the meter parameterisation mode only is protected with a hardware lock and with software protection measures (password and encryption algorithm). A hardware lock is the Param pushbutton, which is located under the meter cover. When this pushbutton is pressed, a hardware lock is unlocked so that the meter parameterisation can be performed. It is performed in a same manner as meter setting via communication interface. Note that in this mode the meter parameters defined in the Setting sequence can be programmed too.

Note
Parameters that are to be programmed and edited in the meter parameterisation mode should be specified when ordering the meter.

Typical parameters that can be programmed in the meter parameterisation mode only are:

- a number of rates for energy and demand
- way of tariff change-over and their priority if more sources are defined
- a number of billing periods for which data are stored in the historical registers
- data to be stored in the data profile recorder
- billing reset via communication interface and/or internal tariff device are performed at defined time
- billing reset via the MREa and MRb inputs is performed at defined time
- duration of demand and data profile period (expressed in minutes)
- duration of subinterval of demand period (expressed in minutes)
- duration of pulse at the end of demand periods
- time window in which the MPE external pulse should be received
- duration of a billing period (with resolution of 0.1 hours or with a time stamp)
- forgiveness time (period of non-recording maximum demand after power failure)
- minimum duration of power shortage after which the forgiveness time is started
- pulse edge on which the RTC is synchronised via the MPE input
- pulse form for the MPAn output (demand period output)
- a number of digits in front of decimal point and behind it for the metering data
- a list of data in the Setting sequence
- passwords and algorithms for access to certain registers
- password for meter parameterisation via communication interfaces
- reset of registers with metering data
- reset of the billing resets counter
- setting output pulse constant value
- pulse form and duration for output pulses

All parameters mentioned in item 16.1.3 can be programmed in the meter parameterisation mode too. On request some parameters which are mentioned that can be programmed in the meter setting mode can be programmed only in the meter configuration mode.

16.3. METER CONFIGURATION

The TE851 meters are configured in the factory in compliance with a detailed meter specification from an electric utility order. As the TE851 meters are complex devices with a lot of different options, some of them even excluding each other, a software Order is available to electric utilities so that all relevant data of a required meter version can be defined in easy and clear way. Meter configuration involves both meter hardware and some fundamental software performance. The following meter specifications are used when meter is configured:

- LCD version
- required meter inputs and outputs (including a number of their ground terminals and position of their terminals in the meter terminal block)
- required communication interfaces (CS, RS232)
- memory capacity (regarding required meter functions)
- RTC back-up
- meter functions (e.g. metering in certain quadrants, a number of previous billing periods for which data are stored, data profile recorder, data to be registered with the data profile recorder, load limiter and its version, etc.)
- size of field of registers for measuring values and parameters
- meter status indicators
- anti-fraud protection measures (locks, passwords for different levels of authorisation and coding algorithms)
- meter parameters which can be programmed in the meter setting mode and in the meter parameterisation mode
- language
- data names and messages displayed on the LCD
- definition of required constants, data formats and units of displayed quantities
- setting of different program constants

When a meter is configured its configuration can not be modified subsequently.

17. FORMATS, CONSTANTS, UNITS

A number of pulses generated by the metering modules are stored in a raw binary form in the meter memory. For each measured quantity a corresponding constant, data format and unit are defined and stored in the meter memory too. A metering value displayed on the LCD or down-loaded via communication interfaces is a result of division of a binary number of pulses with the corresponding constant of measurement **K_o**. In this way a measured quantity is defined with **data format, constant** and **unit (FCU set)**. Up to 64 FCU sets can be defined in the TE851 meters when they are configured.

An FCU set that is used for calculation of measured energies for displaying it on the LCD is given in the following table:

Designation	Data Format	Constant K_m	Constant K_i	Constant K_v	Unit
FCU4	8.3	120,000 imp/kWh	300	1,000	MWh

where

- **data format** 8.3 means that the data field is 8-digit and 3 digits are decimals. Therefore the energy data will be displayed or down-loaded in a form **XXXXX.XXX**
- **K_m** constant is a **measuring module constant** which depends on the meter ratings, i.e. phase voltage and maximum current (e.g. 120,000 imp/kWh for active energy and 120,000 imp/kVarh for reactive energy).
- **K_i** constant is a **current transformer ratio** (e.g. 1500/5 A).
- **K_v** constant is a product of a **voltage transformer ratio K_{vo}** (e.g. 110,000/110 V) and a **constant of compensation of voltage transformers error K_c** (e.g. 1 if no voltage transformer error compensation is required), i.e.:

$$K_v = K_{vo} \times K_c$$

Note
A number of the FCU sets is defined during meter configuration, therefore it can not be subsequently modified. The FCU sets can be programmed and assigned to certain measured quantities by the meter parameterisation via communication interface.

17.1. CONSTANTS

A measuring module constant **K_m** is programmed when a meter is configured separately for active and reactive energy measurement. Therefore there are two constants stored in two registers.

Register	Measuring module constant
N_336	Active energy 3-phase
N_337	Reactive energy 3-phase

A transformer operated meter is connected on a secondary side of a current transformer or current and voltage transformers, i.e. measured energy is so called secondary value. To calculate actual energy on the primary side of the transformer(s) the secondary value should be multiplied with the CT ratio or with the CT and VT ratios to read metering values in so called primary values. The TE851 meters enable that voltage transformer ratios can be programmed so that displayed metering values primary values. A current transformer ratio **K_i** is stored in a register **0.4.2**. A voltage transformer constant **K_v** is stored in a register **0.4.3.** If no voltage transformer error compensation is required, it is equal to a voltage transformer ratio K_{vo} (i.e. $K_v = K_{vo}$), otherwise a product of a voltage transformer ratio K_{vo} and the voltage transformer error compensation constant K_c is stored there. If for any reason is required that secondary values are displayed on the LCD, in registers **0.4.2** and **0.4.3** should be entered values 1 instead of transformer ratios.

Examples of calculation of error compensation constants K_c of a voltage transformer

1. *A voltage transformer has e.g. a positive error 0.6% and it should be compensated. The compensation constant Kc is*

$$K_c = \frac{1}{1 + 0.006} = \frac{1}{1.006} = 0.994$$

2. *A voltage transformer has e.g. a negative error 0.4% and it should be compensated. The compensation constant **Kc** is*

$$K_c = \frac{1}{1 - 0.004} = \frac{1}{0.996} = 1.004$$

*A constant of measurement **K_o** is calculated as*

$$K_o = \frac{K_m}{K_i \times K_v} \quad \text{(imp/kWh, imp/kvarh)}$$

*A primary value of energy **W_p**, which will be displayed on the LCD, is calculated by dividing a number of pulses stored in the meter register with the constant of measurement i.e.:*

$$W_p = \frac{\text{register value (imp)}}{K_o}$$

Example

*A meter with the metering module constant **K_m** = 100,000 imp/kWh is connected via a current transformer 600/5 A (i.e. **K_i** = 120) and a voltage transformer 10,000/100 V (i.e. **K_{vo}** = 100). The voltage transformer error is positive 0.3% and should be compensated.*

The voltage constant is

$$K_v = K_{vo} \times K_c = 100 \times \frac{1}{1 + 0.003} = \frac{100}{1.003} = 99.7$$

The constant of measurement is

$$K_o = \frac{K_m}{K_i \times K_v} = \frac{100{,}000}{120 \times 99.7} = 8.3584 \quad \text{(imp/kWh, imp/kvarh)}$$

17.2. DATA FORMATS

All values of measurement are stored in a binary form (as a number of quantified pulses) in the meter memory. Whenever a measuring data is displayed or is transferred via communication interfaces, that binary number is divided with the constant of measurement and formatted in a programmed **data format.** A data format defines a number of digits in the data field as well as how many of them are decimals. Maximum length of a data field is 8 digits.

Examples

Data format ***7.2*** *forms data as 5 integers and 2 decimals (total 7 digits), i.e.:* ***XXXXX.XX***

Data format ***7.5*** *forms data as 2 integers and 5 decimals (total 7 digits), i.e.:* ***XX.XXXXX***

Data formats can be edited in the meter setting mode via communication interface by editing a table of FCU sets. Standard measuring data appearance is with leading zeroes but other data appearances are also possible on request.

Example

Value of a metering data is 12,34567 and is formatted 6.2. The following data value appearances can be set:

Data appearance	Note
12.34567	Data is not formatted
xx12.34	Formatted data with right alignment
12.34xx	Formatted data with left alignment
0012.34	**Formatted data with leading zeroes**
12.34	Formatted data without leading zeroes

x - blanks

Note

When ordering meters data formats and the data value appearance should be specified.

17.2.1. Data format in the meter testing mode

In spite of standard data format for energy 8.2 (6 integers + 2 decimals) energy data can be displayed with higher resolution in the meter testing mode. In this mode energy data can be displayed with resolution up to 5 decimals. This enable that duration of meter testing at low loads can be shortened 10, 100 or 1,000 times. A number of decimals in the meter testing mode is set at meter configuration procedure. When the meter is in the testing mode a value 1 is set in the register **C.59.1** otherwise there is value 0.

17.3. UNITS AND NAMES OF MEASURING DATA

Units of quantities are accompanied to their values when data of measurement are displayed on the LCD or transferred via communication interfaces. Both units and names of measuring data can be omitted in the DRO sequence by setting corresponding bits to 0 or 1 of a byte in the register **N_233** in the meter parameterisation mode.

Register N_233	Units and names of measuring data in DRO sequence	
	Bit value 0	**Bit value 1**
Bit 0	Unit is not accompanied to the value	Unit is accompanied to the value
Bit 1	Name of data is not in front of the value	Name of data is in front of the value
Bit 2	Unit is not accompanied to the previous values	Unit is accompanied to the previous values

18. PROTECTION AGAINST FRAUD AND METER TAMPERING

The TE851 meters are well protected against any attempt to tamper the measuring results and unauthorised access to the registers containing parameters that influence results of measurements. For this purpose different protection measures are implemented in the TE851 meters. They can be divided into hardware protection and the software one.

Hardware protection includes:

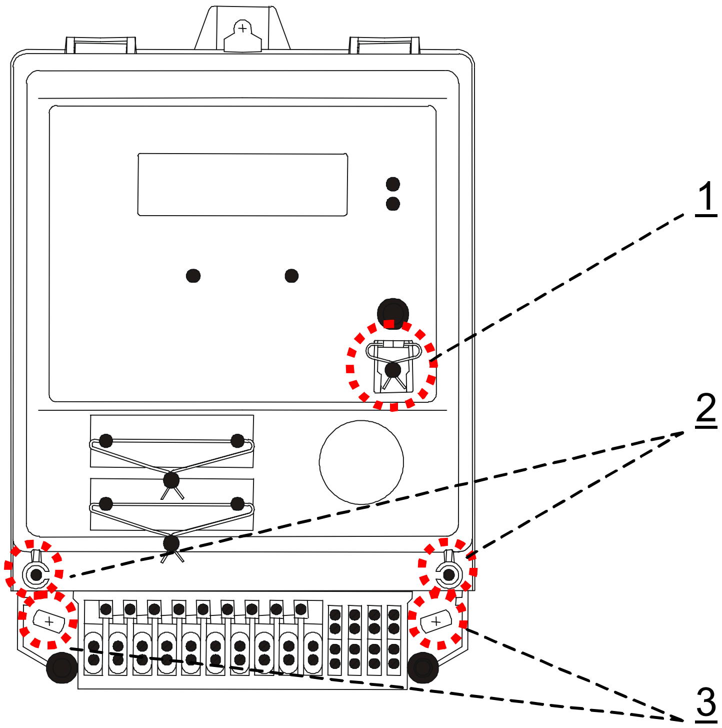
- sealing of a terminal cover and a meter cover with wire and two lead seals
- a bolt which immobilise the Reset pushbutton can be sealed
- protection of the meter parameterisation with the PARAM switch under the meter cover which is sealed with two led seals

Software protection includes:

- software locks of registers, passwords and a password with an encryption algorithm
- temporally disabling of programming the meter via communication interfaces if wrong passwords were used
- counting the billing resets
- logbook where changes of parameters which influence results of measurement are recorded together with a time stamp and can not be deleted.
- some meter statuses can be registered in the data profile recorder, e.g.:
  - reversed phase sequence
  - counters of power shortages
- detection of different incorrect operations of a meter

18.1. HARDWARE PROTECTION

Places of sealing the terminal cover, the meter cover and the Reset pushbutton are shown in the figure bellow.



1. The Reset pushbutton can not be pressed without breaking its seal. Therefore it is not possible to perform a billing reset or set meter parameters via the pushbuttons.
2. The Param pushbutton can not be pressed without breaking the seals on the meter cover and removing it. Therefore parameters can not be changed in the meter parameterisation mode.
3. Access to the main and auxiliary terminals is not possible without breaking the seals on the terminal block. Therefore fraud via meter terminals is not possible.

18.2. SOFTWARE PROTECTION

Software locks of registers

All registers that contains parameters which influence or contains results of measurement, meter statuses or different counters of events are protected with up to 8 software locks. These locks should be unlocked first if content of the register is to be changed.

Passwords

There are two passwords in the registers **C.58.3** and **C.58.4** as well as a password with an encryption algorithm. The registers **C.58.3** and **C.58.4** are protected with a password both against changing and reading. In case of a password with algorithm, one should have a key for encoding/decoding the password, otherwise access to the registers protected with it is disabled.

Levels of authorisation

Right to access to different registers is organised with up to 8 levels of authorisation, i.e. meter operators can be divided into 8 groups with different rights of manipulating the meter.

Communication disabled function if three wrong passwords have been received

In case when three wrong passwords have been entered into the meter via communication interface, meter programming via communication interfaces is temporally disabled for a certain time. Besides, every wrong password is counted by the wrong passwords counter and registered in the logbook together with date and time of the attempt. In this way the meter is protected against attempts to break the meter passwords.

Counting of billing resets

When a billing reset is performed, date and time as well as way of reset are recorded in the logbook. The counter of billing resets is incremented for one with each billing reset. In this way non-authorised billing resets are recorded.

Logbook records

All significant events that give information on failures, interventions into the meter, settings, etc. are recorded into the logbook. The logbook can not be deleted except if the meter is re-configured. Therefore eventual unauthorised interventions into the meter are registered permanently in its logbook.

Meter statuses registered in the data profile recorder

Different meter statuses or counters of events can be registered by the data profile recorder. This enables registration of uncommon meter operation conditions, which might be caused by non-authorised intervention into the meter connection, e.g..

- reversed phase sequence
- presence of phase voltages
- counter of voltage failures

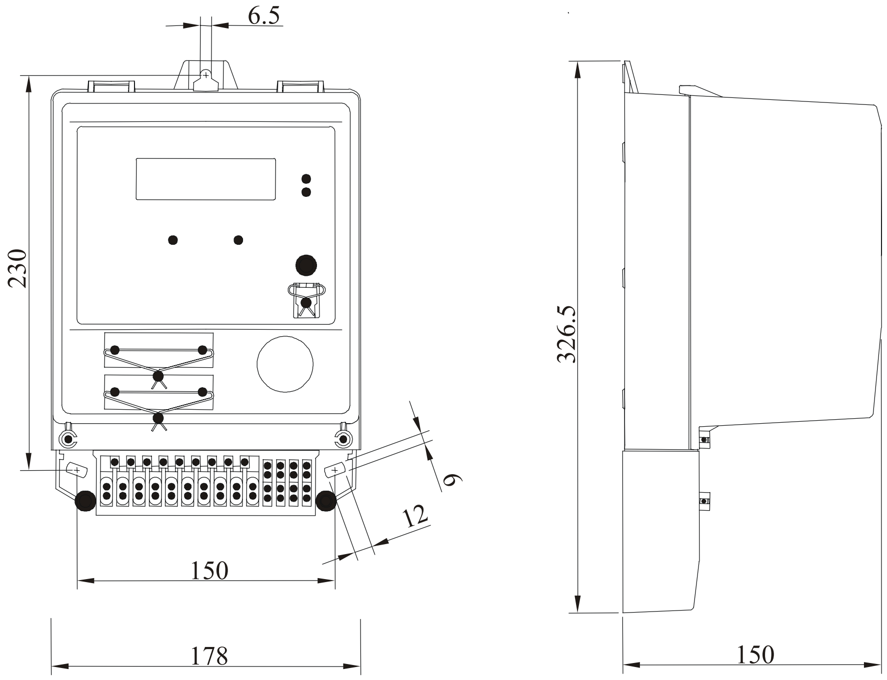
Note:
In case of reversed phase sequence active energy is registered correctly without additional error but reactive energy is registered in a wrong quadrant, e.g. imported inductive reactive energy (first quadrant) can be registered as exported capacitive reactive energy (fourth quadrant) or exported inductive reactive load (third quadrant) depending on which phases are reversed.

19. TECHNICAL DATA

Version	Rated current	Maximum current	Thermal current
1(1.2) A	*1 A*	*1.2 A*	*2 A*
1(2) A	*1 A*	*2 A*	*3 A*
1-5(6) A	*5 A*	*6 A*	*8 A*
5(10) A	*5 A*	*10 A*	*15 A*
5(6) A	*5 A*	*6 A*	*8 A*

Accuracy class	**Cl.**	(kWh) 0.2S or 0.5S (IEC 60687)
		(kvarh) class 2, 3 (IEC 61268), calibrated 0.2%, 0.5%,1%,
Measuring voltage		3 x 58/100V, 3 x 63/110V 3 x 115/200V, 3 x 127/220V 3 x 220/380V, 3 x 230/400V, 3x240/415
Auxiliary voltage		from 58V to 230V * auxiliary voltage can be applied only if an internal auxiliary power supply is built in (on request only). ** external power supply and internal auxiliary power supply are not posible in the same meter.
Voltage range		0.8 ... 1.15 Un
Short-circuit current		30 I_n
Starting current		< 2 mA (0.05% Pn)
Rated frequency	**f_n**	50 Hz or 60 Hz
Temperature range:		
Operation	**T_o**	-25°C ... +55°C
Operation (limit)		-25°C ... +60°C (IEC 61036 outdoor)
Storage	**T_s**	-25°C ... +70°C
Self-consumption:		
Voltage circuit		8.8 VA (at 58V)
Current circuit		0.06 VA (at 5A)
Tariff		1.6 VA (at 230V)
Pulse width (relay)	Ti	80 ms (other values on request)
Type of outputs		PHOTO-MOS relay, potential-free
Relay ratings		25 VA (100 mA, 250 V AC)
Impulse outputs:		
Contact		PHOTO-MOS relay with make contact
Permitted load		≅250V; 0.1A / 25 VA
Impulse length		from 10 to 2500 ms (programmable in steps of 10 ms)
Impulse frequency		max 5 imp/s at impulse length 80 ms (at a shorter impulse a larger impulse frequency is possible)
Control inputs:		58 V - 230 V
voltage threshold: ON OFF Current consumption		U ≥ 50 V U < 20 V < 2 mA @ 58V < 10 mA @ 230V
Electrostatic discharge	**ESD**	15 kV (IEC 60801-2)
HF Magnetic field		10 V/m (IEC 60801-3)

Burst test		4 kV (IEC 60801-4)
Dielectric strength		4 kV_{rms}, 50 Hz, 1 min
Impulse voltage		6 kV, 1.2/50 µs
Insulation between voltage circuits		Impulse voltage 6 kV, 1.2/50µs Dielectric strength 4 kV, 50 Hz, 1 min
Relative humidity		In compliance with IEC 60687 Tab. 5
LED for optical reading: Impulse frequency Impulse length		 ≤ 40 Hz approx. 8 ms
RTC accuracy		Crystal: 6 ppm = ≤ ±3 min./year (at T_{op}= +25°C)
RTC Power back-up:		
Super-Cap		1F (for min. 250 h of back-up)
Li-battery		Operation reserve: 2 years (at TE851) Life span: 10 years
LP recorder:		
Status information		8 bit
Channels		up to 32 - measured quantities can be programmed. Default is 4 (A+, A-, R+, R-).
Reading		in compliance with DIN 43863-3 with R5 or R6 (=partial block) command from-to reading is possible (daily, weekly, monthly) only one channel or multiple channels simultaneously
Communication interfaces:		IEC 61107 - mode C (with encrypted or non-encrypted password)
IR-optical interface		Baudrate: max. 9600 Bit/s
CS-20 mA-interface		Baudrate max. 9600 Bit/s Passive, CL0 in compliance with DIN 66 348, Part 1
Housing:		Designed according to DIN 43857
Mounting		On-wall
Material		Polycarbonate, gray coloured
Fire retardand		Self-extinguish rate: IEC60695-5-11(960ºC), UL94 (94V0)
Overall Dimensions		327 x 178 x 150 mm
Fixing points		150 x 230 mm
Protection against water and dust		IP53
Mass		approx. 2.5 kg


6.5
230
9
12
150
178
326.5
150

20. METER TYPE AND VERSIONS

Meter Type	Un (V)	In (A)	Constant RL, RLW, RLB imp/kWh	Constant RAW, RAB imp/kWh
TE851	3x58/100 or 3x63/110	1	600 000	500 000 / N *2
		1(2)	300 000	250 000 / N
		5	120 000	100 000 / N
		5(10)	60 000	50 000 / N
		5//1	120 000	100 000 / N
	3x115/200 or 3x127/220	1	300 000	250 000 / N
		1(2)	150 000	125 000 / N
		5A	60 000	50 000 / N
		5(10)	30 000	25 000 / N
		5//1	60 000	50 000 / N
	3x220/380 or 3x230/400 or 3x240/415	1	150 000	125 000 / N
		1(2)	75 000	62 500 / N
		5	30 000	25 000 / N
		5(10)	15 000	12 500 / N
		5//1	30 000	25 000 / N
DE851	3x100 or 3x110	1	600 000	500 000 / N *2
		1(2)	300 000	250 000 / N
		5	120 000	100 000 / N
		5(10)	60 000	50 000 / N
		5//1	120 000	100 000 / N
	3x200 or 3x220	1	300 000	250 000 / N
		1(2)	150 000	125 000 / N
		5A	60 000	50 000 / N
		5(10)	30 000	25 000 / N
		5//1	60 000	50 000 / N
	3x380 or 3x400 or 3x415	1	150 000	125 000 / N
		1(2)	75 000	62 500 / N
		5	30 000	25 000 / N
		5(10)	15 000	12 500 / N
		5//1	30 000	25 000 / N

TE - polyphase 3-element precision meter with LCD, real-time-clock and communication
DE - polyphase 2-element precision meter with LCD, real-time-clock and communication

*1 - LED costants can be on customer request 3 times smaller. This has to be defined with order.
*2 - N = integer divisor - default = 10 - suggested values - 1,2,5,**10**,20,50,100,200,500,..

Output constant is always meant as secondary.

21. METER TYPE DESIGNATION

TE851 - A n m R n m - E I V n m L n m C n m - M n K n m p Z n

TE851	**polyphase 3-element precision meter**
DE851	**polyphase 2-element precision meter**
A	**Active energy**,
n = 2	class 0.2S (IEC 60687)
n = 3	class 0.5S (IEC 60687)
m = 1	one energy-flow direction
m = 2	two energy-flow directions
R	**Reactive energy**
n = 2	0.2 %
n = 3	0.5 %
n = 4	1 %
n = 5	class 2 (IEC 61268)
n = 6	class 3 (IEC 61268)
m = 1	one energy-flow direction (Q+ = Q1 + Q2)
m = 2	two energy-flow directions (Q+=Q1 + Q2 ; Q-=Q3 + Q4)
m = 3	inductive import, capacitive export (Q1, Q4)
m = 4	inductive import , inductive export (Q1, Q3)
m = 5	4-quadrant (Q1, Q2, Q3, Q4)
m = 6	4-quadrant, imp., exp. (Q+, Q-, Q1, Q2, Q3, Q4)
-	dash
E	**External supply**
I	**Internal auxiliary supply**
V	**Control inputs**
n = 1	1 control input
...	
n = 3	3 control inputs (max.)
m = 1	inputs - capacitor type
L	**PHOTO-MOS relay outputs**
n = 1	1 output
...	
n = 8	8 outputs (max.)
m = 1	make contact
C	**Energy-flow direction relay**
n = 1	1 energy-flow direction relay
n = 2	2 energy-flow directions relay
m = 2	PHOTO-MOS relay
-	dash
M	**Additional device**
n = 2	RTC with a super-cap
n = 3	RTC with a Li-battery and a super-cap
K	**Communication interface**
n	*Version of the 1st interface*
n = 0	IR optical port
n = 1	CS-20 mA
n = 2	RS-232
n = 3	RS-485
m	*Version of the 2nd interface*
m = 1	CS-20 mA
m = 2	RS-232
m = 3	RS-485
p	*Version of the 3rd interface*
p = 2	RS-232
p = 3	RS-485
Z	Data profile recorder
n = 2	128k SRAM

NOTE!! External supply and Internal auxiliary supply are not possible simultaneously.

Example:

TE851-A22R36-V21L61-M2K02Z2 = polyphase 3-element precision meter, active cl. 0.2S bidirectional, reactive cl.0.5S four-quadrant with import and export, two control inputs, 6 outputs, RTC with super-cap, IR optical port, RS-232 interface

22. Appendix A: COUNTERS OF EVENTS AND ELAPSED TIME

In the TE851 meters there are the following counters of events and elapsed time:

- **PDWN resets counter**

The counter is incremented by 1 whenever reset PWDN occurs, i.e. at longer power shortages and after each meter parameterisation or setting.

- **WDOG resets counter**

The counter is incremented whenever reset WDOG occurs, i.e. at shorter power shortages and in case of disturbances during the program operation.

- **Counter of meter vital data refreshing**

The meter vital data are refreshed every two hours in the EEPROM memory. The counter is incremented by 1 for every 8 refreshments of the meter vital data.

- **Counter of lost recording periods in the data profile recorder**

Data to be recorded in the data profile recorder are checked if they are valid or not. If they are not valid they will not be entered into the data profile recorder and value 0 is registered instead. Recording periods with registered 0 instead data values are considered as the lost ones. This counter counts a number of such recording periods.

- **Counter of elapsed time of RTC backed-up by Li-battery**

This counter registers elapsed time (expressed in minutes) when a meter is not externally supplied (due to power failure or the meter is not connected to network) so that RTC is backed-up with meter internal power supply sources. When the elapsed time is close to two years (i.e. 1,051,200 minutes) the Li-battery should be replaced.

- **Counter of the meter parameterisation**

At each meter parameterisation this counter is incremented by one.

- **Counter of billing resets**

When a billing reset is performed (RR), this counter is incremented by one. It indicates a total number of billing resets.

- **Counter of billing resets stored in the memory**

This counter indicates a number of performed billing resets (RR) stored in the meter memory.

- **Counters of L1, L2 and L3 phase failure**

These three counters count a number of phase L1, L2 and L3 failures respectively. They detect all failures of phases that last longer than 6 seconds.

23. Appendix B: TE851 METER STATUSES

The following statuses can be set in the meter:

Tariff input E0 Tariff input E1 Tariff input E2 Tariff input P0 Tariff input P1 Tariff input P2
Demand period input (MPE) active signal
MZE active signal
Input for billing reset (MRE-a) active signal
Input for billing reset (MRE-b) active signal
MP1 impulse of power measuring interval
+P active energy flow-direction -P active energy flow-direction
Tariff output E0 Tariff output E1 Tariff output E2 Tariff output P0 Tariff output P1 Tariff output P2
Disabled demand measurement, MZA output
Billing reset output MRAa Billing reset output MRAb
Tariff T1 active - energy Tariff T2 active - energy Tariff T3 active - energy Tariff T4 active - energy Tariff T5 active - energy Tariff T6 active - energy Tariff T7 active - energy Tariff T8 active - energy
Tariff M1 active - demand Tariff M2 active - demand Tariff M3 active - demand Tariff M4 active - demand Tariff M5 active - demand Tariff M6 active - demand Tariff M7 active - demand Tariff M8 active - demand
Active energy (DA) or apparent energy S+ flow-direction Reactive energy flow-direction Q+ (DQ)
Phase L1 ON-status Phase L1 OFF-status Phase L2 ON-status Phase L2 OFF-status Phase L3 ON-status Phase L3 OFF-status

Demand control - channel 1 active Demand control - channel 1 inactive Demand control - channel 2 active Demand control - channel 2 inactive Demand control - channel 3 active Demand control - channel 3 inactive Demand control - no channel active Demand control - at least one channel active
Presence of a phase voltage on all phase terminals Absence of one or two phase voltages Reversed phase sequence connection Phase sequence connection OK
Total energy in 1st quadrant Total energy in 2nd quadrant Total energy in 3rd quadrant Total energy in 4th quadrant Total energy in 1st or 2nd quadrant Total energy in 2nd or 3rd quadrant Total energy in 3rd or 4th quadrant Total energy in 4th or 1st quadrant Total energy in 1st or 3rd quadrant Total energy in 2nd or 4th quadrant
Export energy flow-direction for P or S (total) ⇒ 2nd or 3rd quadrant Export energy flow-direction for Q (total) ⇒ 3rd or 4th quadrant
Disabled measurement of P and S (ZA) Disabled measurement of S (ZQ)
Unlocked the password 1 software lock Password with encryption algorithm active Parameters setting with the pushbuttons Meter setting mode Meter parameterisation via communication interface Unlocked the password 2 software lock Unlocked the spare software lock Unlocked the master software lock Lock for meter parameterisation Lock for meter setting
Priority communication RS/CS active Non-priority communication IR- optical interface inactive Ripple control (MTK) message reception in progress No ripple control (MTK) signal detected
Disabled billing reset with a pushbutton Disabled billing via communication interface Billing reset is not disabled

Error on meter vital data Meter vital data OK Error on meter configuration data Meter configuration data OK Error on Format Constant Units (FCU) FCU OK Error on sequences Sequences OK Error in tariff change-over program Tariff change-over program OK Error in calendar for time of billing resets Calendar for time of billing resets OK Error in current time of RTC Current time of RTC OK Historic error RTC Historic RTC OK Microcomputer OK Error on microcomputer Error at communication with microcomputer Invalid data from microcomputer
Power down RESET Watch dog RESET
LP recorder in operation LP recorder not in operation
A day is a holiday A day is not a holiday
Fixed demand period, asynchronous mode Rolling demand period, asynchronous mode Fixed demand period, asynchronous mode, with external signal via MPE input Rolling demand period, asynchronous mode, with external signal via MPE input Fixed demand period, synchronous mode Rolling demand period, synchronous mode
Communication status - successful communication with the meter Communication status - data down-loading (Data Read Out) Communication status - manufacture specific Communication status - meter in programming mode
Over-flow of the counter of errors in communication with the microcomputer Counter of errors in communication with the microcomputer is not over-flowed Li-battery have been backing-up the RTC for almost 2 years; time to replace the Li-battery Li-battery has not backed-up the RTC for almost 2 years Over-flow of the WATCH DOG resets counter WATCH DOG resets counter is not over-flowed
Meter in the testing mode (increased resolution of energy data on the LCD) Meter in the standard mode
Units are written next to the values of measured quantities Data names are written in front of the values of measured quantities
Meter programming temporally disabled due to successively entered wrong passwords

Tariff 1 - for energy: not active; - for demand: not active Tariff 1 - for energy: not active; - for demand: active Tariff 1 - for energy: active; - for demand: not active Tariff 1 - for energy: active; - for demand: active Tariff 2 - for energy: not active; - for demand: not active Tariff 2 - for energy: not active; - for demand: active Tariff 2 - for energy: active; - for demand: not active Tariff 2 - for energy: active; - for demand: active Tariff 3 - for energy: not active; - for demand: not active Tariff 3 - for energy: not active; - for demand: active Tariff 3 - for energy: active; - for demand: not active Tariff 3 - for energy: active; - for demand: active Tariff 4 - for energy: not active; - for demand: not active Tariff 4 - for energy: not active; - for demand: active Tariff 4 - for energy: active; - for demand: not active Tariff 4 - for energy: active; - for demand: active Tariff 5 - for energy: not active; - for demand: not active Tariff 5 - for energy: not active; - for demand: active Tariff 5 - for energy: active; - for demand: not active Tariff 5 - for energy: active; - for demand: active Tariff 6 - for energy: not active; - for demand: not active Tariff 6 - for energy: not active; - for demand: active Tariff 6 - for energy: active; - for demand: not active Tariff 6 - for energy: active; - for demand: active Tariff 7 - for energy: not active; - for demand: not active Tariff 7 - for energy: not active; - for demand: active Tariff 7 - for energy: active; - for demand: not active Tariff 7 - for energy: active; - for demand: active Tariff 8 - for energy: not active; - for demand: not active Tariff 8 - for energy: not active; - for demand: active Tariff 8 - for energy: active; - for demand: not active Tariff 8 - for energy: active; - for demand: active
Tariff change-over for energy is controlled by a tariff program stored in the microcomputer Tariff change-over for energy is controlled externally via tariff inputs TEn Internal ripple control receiver* controls tariff change-over for energy (*not implemented yet) Tariff change-over for energy controlled externally via a communication interface
Tariff change-over for demand is controlled by a tariff program stored in the microcomputer Tariff change-over for demand is controlled externally via tariff inputs MEn Internal ripple control receiver* controls tariff change-over for demand (*not implemented yet) Tariff change-over for demand controlled externally via a communication interface
Communication output bit 0 Communication output bit 1 Communication output bit 2 Communication output bit 3 Communication output bit 4 Communication output bit 5 Communication output bit 6 Communication output bit 7
Disabled demand measurement (Forgiveness period) Enabled demand measurement
Daylight-saving period Standard time
All Systems Go All Systems No-Go
Always fulfilled condition

24. Appendix C: EDIS CODES AND DATA NAMES

EDIS code	Explanation	Data name
		CUMULATIVE MAXIMUM DEMAND 3-PHASE TIME-OF-USE
X.2.1		L123 Cumulative maximum demand, tariff 1, register 1, 2, 3
X.2.2	X=1 ⇒ P+	L123 Cumulative maximum demand, tariff 2, register 1, 2, 3
X.2.3	X=2 ⇒ P-	L123 Cumulative maximum demand, tariff 3, register 1, 2, 3
X.2.4	X=5 ⇒ Q1	L123 Cumulative maximum demand, tariff 4, register 1, 2, 3
X.2.5	X=6 ⇒ Q2	L123 Cumulative maximum demand, tariff 5, register 1, 2, 3
X.2.6	X=7 ⇒ Q3	L123 Cumulative maximum demand, tariff 6, register 1, 2, 3
X.2.7	X=8 ⇒ Q4	L123 Cumulative maximum demand, tariff 7, register 1, 2, 3
X.2.8		L123 Cumulative maximum demand, tariff 8, register 1, 2, 3
		3-PHASE TOU MOMENTARY DEMAND IN CURRENT D.P.
X.4.1		L123 Momentary demand in cur. dem. per., tariff 1, regist. 1, 2, 3
X.4.2	X=1 ⇒ P+	L123 Momentary demand in cur. dem. per., tariff 2, regist. 1, 2, 3
X.4.3	X=2 ⇒ P-	L123 Momentary demand in cur. dem. per., tariff 3, regist. 1, 2, 3
X.4.4	X=5 ⇒ Q1	L123 Momentary demand in cur. dem. per., tariff 4, regist. 1, 2, 3
X.4.5	X=6 ⇒ Q2	L123 Momentary demand in cur. dem. per., tariff 5, regist. 1, 2, 3
X.4.6	X=1 ⇒ Q3	L123 Momentary demand in cur. dem. per., tariff 6, regist. 1, 2, 3
X.4.7	X=8 ⇒ Q4	L123 Momentary demand in cur. dem. per., tariff 7, regist. 1, 2, 3
X.4.8		L123 Momentary demand in cur. dem. per., tariff 8, regist. 1, 2, 3
		MAX. DEMAND 3-PHASE TIME-OF-USE IN CURRENT MONTH
X.5.1		L123 Maximum demand in current month, tariff 1, register 1, 2, 3
X.5.2	X=1 ⇒ P+	L123 Maximum demand in current month, tariff 2, register 1, 2, 3
X.5.3	X=2 ⇒ P-	L123 Maximum demand in current month, tariff 3, register 1, 2, 3
X.5.4	X=5 ⇒ Q1	L123 Maximum demand in current month, tariff 4, register 1, 2, 3
X.5.5	X=6 ⇒ Q2	L123 Maximum demand in current month, tariff 5, register 1, 2, 3
X.5.6	X=7 ⇒ Q3	L123 Maximum demand in current month, tariff 6, register 1, 2, 3
X.5.7	X=8 ⇒ Q4	L123 Maximum demand in current month, tariff 7, register 1, 2, 3
X.5.8		L123 Maximum demand in current month, tariff 8, register 1, 2, 3

EDIS code	Explanation	Data name
		MAXIMUM DEMANDS 3-PHASE
1.6.0		L123 Maximum demand of active energy +
2.6.0		L123 Maximum demand of active energy -
5.6.0		L123 Maximum demand of reactive energy Q1
6.6.0		L123 Maximum demand of reactive energy Q2
7.6.0		L123 Maximum demand of reactive energy Q3
8.6.0		L123 Maximum demand of reactive energy Q4
		MAXIMUM DEMAND 3-PHASE TIME-OF-USE
X.6.1	X=1 ⇒ P+ X=2 ⇒ P- X=5 ⇒ Q1 X=6 ⇒ Q2 X=7 ⇒ Q3 X=8 ⇒ Q4	L123 Maximum demand, tariff 1, register 1, 2, 3
X.6.2		L123 Maximum demand, tariff 2, register 1, 2, 3
X.6.3		L123 Maximum demand, tariff 3, register 1, 2, 3
X.6.4		L123 Maximum demand, tariff 4, register 1, 2, 3
X.6.5		L123 Maximum demand, tariff 5, register 1, 2, 3
X.6.6		L123 Maximum demand, tariff 6, register 1, 2, 3
X.6.7		L123 Maximum demand, tariff 7, register 1, 2, 3
X.6.8		L123 Maximum demand, tariff 8, register 1, 2, 3
		TOTAL ENERGY 3-PHASE
1.8.0		L123 Active energy +
2.8.0		L123 Active energy -
3.8.0		L123 Reactive energy import Q+
4.8.0		L123 Reactive energy export Q-
5.8.0		L123 Reactive energy Q1
6.8.0		L123 Reactive energy Q2
7.8.0		L123 Reactive energy Q3
8.8.0		L123 Reactive energy Q4
		ENERGY 3-PHASE TIME-OF-USE
X.8.1	X=1 ⇒ A+ X=2 ⇒ A- X=3 ⇒ R+ X=4 ⇒ R- X=5 ⇒ R1 X=6 ⇒ R2 X=7 ⇒ R3 X=8 ⇒ R4	L123 Energy, tariff 1, register 1, 2, 3
X.8.2		L123 Energy, tariff 2, register 1, 2, 3
X.8.3		L123 Energy, tariff 3, register 1, 2, 3
X.8.4		L123 Energy, tariff 4, register 1, 2, 3
X.8.5		L123 Energy, tariff 5, register 1, 2, 3
X.8.6		L123 Energy, tariff 6, register 1, 2, 3
X.8.7		L123 Energy, tariff 7, register 1, 2, 3
X.8.8		L123 Energy, tariff 8, register 1, 2, 3

EDIS code	Explanation	Data name
		ERRORS + STATUS
F.F		Function error
C.3		Status I/O
C.4		Internal Status 1
C.5		Internal Status 2
C.7.0		Total power shortage counter
C.50.0		WDOG counter
C.7.1		L1 phase voltage failure counter
C.7.2		L2 phase voltage failure counter
C.7.3		L3 phase voltage failure counter
		REAL-TIME CLOCK
C.55.0		Elapsed time of current demand period
C.55.9		Tuning factor of the RTC quartz crystal frequency
C.59.0		External RTC synchronisation
C.6.0		Time of the RTC backed-up by Li-battery
0.9.1		Current time (hhmmss)
0.9.2		Current date (dYYMMDD) d - day in week
0.9.4		Current date and time (YYMMDDdhhmmss)
0.9.5		Flag day-light saving period / standard time
N_438		Date and time of start and end of day-light saving period
N_120		Holidays
N_121		Season program - energy
N_123		Weekly tariff change-over program - energy
N_124		Daily tariff change-over program - energy
N_125		Active tariff - energy
N_126		Season program - demand
N_128		Weekly tariff change-over program - demand
N_129		Daily tariff change-over program - demand
N_130		Active tariff - demand
		TARIFF STATUS
C.55.3		Active season - energy
C.55.4		Active season - demand
C.55.5		Part of a day - energy
C.55.6		Part of a day - demand
N_244		Code of active day - energy
N_245		Code of active day - demand
N_471		Flags of tariff change-over controlled by RTC, input, RCR or COM
N_260		Flags of demand period (synchronous, asynchronous, fixed, rolling)
		COMMANDS (E2)
N_285		Delete historical registers
N_353		Delete of Li-battery elapsed-time counter
N_286		Billing reset command
N_354		Delete all registers
N_364		Delete Load profile registers

EDIS code		Data name
		PERMANENT PARAMETERS
N_109		Data Read-out list
N_110		Standard data list
N_111		Data displayed on request list
N_283		List of data programmed in the setting mode
0.8.0		Demand period MP
0.8.2		Subinterval of the demand period
N_115		Menu time-out
N_116		Communication time-out
C.55.10		Duration of the LCD illumination
0.4.2		Current transformer ratio
0.4.3		Voltage transformer ratio and compensation
C.59.3		Index of historical registers
C.59.4		Influence of billing reset and tariff change-over to demand period
C.55.11		Time tolerance for external control of demand period MPE
C.58.2		Communication string
C.58.1		Meter type
0.0.0		Meter address 0
0.0.1		Meter address 1
C.1.0 0.2.0		Meter serial number 0 Software version number
0.0.2		Owners number
0.0.4		Year of manufacturing
C.57.1		CS-interface Baud rate
C.57.2		IR-optical port Baud rate
C.58.3		Password 1 (P1)
C.58.4		Password 2 (P1)
C.55.7		Forgiveness period
C.55.8		Time of power shortage after which forgiveness period is activated
		LOAD PROFILE
0.8.5		LP period
N_204		LP source table
N_434		Limit values for LP
P.01		LP channel 1-8
P.02		LP channel 9-16
P.03		LP channel 17-24
P.04		LP channel 25-32
1.5		A+ - LP channel 1
2.5		A- - LP channel 2
5.5		Q1 - LP channel 3
6.5		Q2 - LP channel 4
7.5		Q3 - LP channel 5
8.5		Q4 - LP channel 6
N_230		Time stamp of the oldest LP value
N_231		Time stamp of the most recent LP value

EDIS code		Data name
		RESET
0.1.0		Reset counter
0.1.1		Number of historical values (previous billing periods)
N_202		Calendar of billing reset times programmable with parameterisation
0.1.2		Time stamp of billing resets (historical values)
N_247		Time stamp of disabled billing reset
C.55.1		Time of disabled billing reset (expressed in minutes)
		SPECIAL REGISTERS
N_236		Pulse length at output pulse relays
C.55.2		Date of the last meter parameterisation
C.50.1		Meter parameterisation counter
C.59.1		Flag of test mode / standard resolution of displayed energy
C.59.2		Flag of demand period mode (synchr., asynchr., rolling, fixed)
P.98		Logbook
N_474		Load limiter parameters (value, limit, curve, period percantage)
N_452		Version of the load limiters (ON/OFF or 3-point controller)
N_451		Demand limit for load limiters or block-tariffs
N_453		Tolerance at 3-point controllers
N_454		Percentage of dem. period in which 3-point controllers are disabled
		PARAMETERS OF METER PARAMETERISATION
0.2.1.01		Software version
0.2.1.02		Parameterisation check sum
0.2.1.03		Time switch program check sum
0.2.1.50		Program time stamp
0.2.1.51		Loader check sum
0.2.1.52		Data format check sum
0.2.1.53		Program check sum
0.2.1.54		Common check sum

25. Appendix D: MODEM REGISTERS

On customer request, Alarm Call-Back function is added, which enables TE851 meter to send alarm directly to control center by modem device. Customer must define conditions when alarm is sent (voltage failure, fatal meter error, etc.).

There are two call-back modes (see ID_663):

1. Normal alarm is used for both PSTN and GSM modems. Communication is established in programming mode (IEC 61107).
2. SMS alarm is used for GSM modems. SMS message is sent.

At meter "power-up" an initialisation string is sent to modem. That enables meter to control modem. Modem functions like initialisation, automatic disconnection, condition selection, etc. are controlled by TE851 meter. Alarm events, message time and modem connection failures are written in Log-Book.

Parameter	Register	Default	Description
Modem initialisation	ID_525		CPIN for GSM modem
Communication mode	ID_526	2	0 = start High priority BAUD is set to 300 baud 1 = start High priority BAUD is set in register C.57.1 2 = modem
Call-back event	ID_649	7	0 = disabled 1 = enabled 7 = F.F + phase sequence incorrect + missing phase
Call-back retry no.	ID_650	2	
Max. call-back time	ID_651	2 min	
Min. call-back time	ID_652	1 min	
Session timeout	ID_653	30 s	
Dial string	ID_654		Example: CMGS="+393292311881"
Alarm string	ID_655		Alarm,@(F.F),@(0.0.0)
Call-back alarm status	ID_656		
Retry counter	ID_657		
Secondary call-back event	ID_662		Alarm is sent when condition is set or reset. (i.e.: phase voltage fault, fatal error, etc.)
SMS/Call-back mode	ID_663	1	0 = modem (e.g. PSTN) 1 = GSM (SMS message)

Note
While Call-back function is executing some other functions are stopped (also tariff change and billing).

Owing to periodical improvements of our products the supplied products can differ in some details from data stated in the Technical Manual.

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