RECTIFIERS FOR FORMATION AND CONDITIONING

- Multiple Circuit Rectifier for Container Formation
- Charge / Discharge Rectifier for Conditioning of Traction and Stationary Batteries
- Charge / Reverse Charge Rectifier for Tackless Plate Formation
- Battery Manager Formation Software

Digatron
power electronics

MULTIPLE CIRCUIT RECTIFIER FOR CONTAINER FORMATION

MCR/MCDR

MCR Series (charge only) and MCDR Series (charge/discharge) are designed for wet container formation. Each cabinet contains multiple circuits for various types of batteries. Energy is fed back to the AC power line during discharge.

MCR/MCDR Series rectifiers are available with current ranges from 5 to 100 amps per circuit. They can be used for air-cooled or water-cooled formation processes.

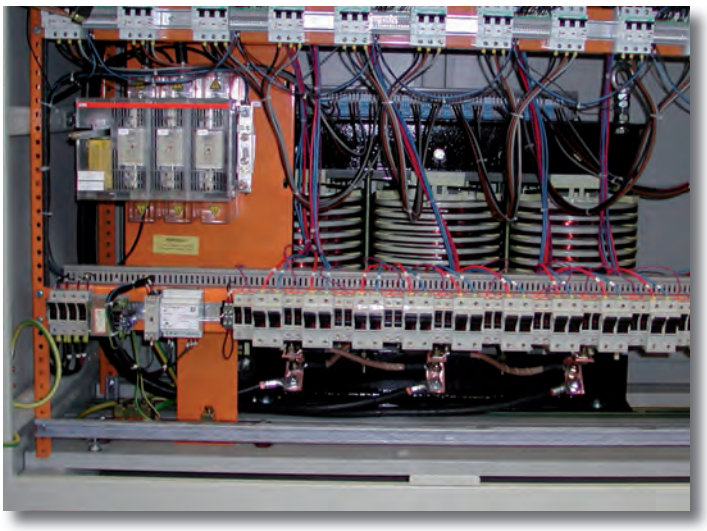
Optionally, depolarization capability with constant resistance discharge is available for MCR Series, and pulse formation capability with constant current pulses is obtainable for MCDR Series.

The number of batteries per circuit determines the maximum DC output voltage of the rectifier, e.g. a 360 V circuit can charge/discharge up to 20 batteries (12 V) in series.

Each circuit is galvanically isolated using separate secondary windings, equipped with an output contactor and protected by a 3-phase AC breaker and two DC fuses.

Battery Manager formation software controls circuits independently, in groups or in parallel for higher current output.

Construction



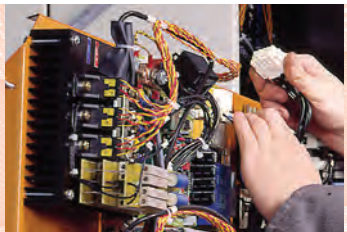
The MCR/MCDR Series cabinets are constructed with framework made of welded steel. Its rugged design allows forklift transportation without additional supports. The cabinets can be installed side by side or back to back.

High circuit density results in a reduced cabinet footprint which requires less floor space.

Hinged front doors with safety interlocks protect operators and permit easy access to DC connections. AC power line and DC output connections are readily accessible.
The protection mode is IP 20.

Fan cooling guarantees optimum heat dissipation.

The cabinet's standard painting is gray (RAL 7032) and has an acid resistant epoxy finish.



Drop-Down Modules

All essential circuit components such as fuses, pulse control boards, SCR's, contactors are housed in drop-down modules. These modules can be easily serviced in the event of a component failure.

1 circuit	2 circuits	2 circuits	10 circuits	2 circuits
100A	60A	30A	5A	50A
SCR	SCR	SCR	SCR	IGBT
charge only	charge only	charge only	charge only	charge only
charge/discharge	charge/discharge	charge/discharge	charge/discharge	

Model Designation	Current [A]	Voltage [V]	Circuits per Cabinet	Total Batteries per Cabinet	Dimensions H x W x D [cm]	Weight approx. [kg]	Power Supply [kVA]
MCR 5-360-60	0-5	10-360	60	1200	195x160 x100	1400	140
MCR 30-360-12	0-30	10-360	12	240	195x160x100	1500	170
MCR 30-360-16	0-30	10-360	16	320	195x210x100	2500	225
MCR 50-360-12 IGBT	0-50	10-360	12	240	195x160x100	2000	280
MCR 50-360-16 IGBT	0-50	10-360	16	320	195x210x100	2300	375
MCR 60-360-12	0-60	10-360	12	240	195x160x100	2100	340
MCR 60-360-16	0-60	10-360	16	320	195x210x100	2300	450
MCR 100-360-6	0-100	10-360	6	120	195x160x100	1900	280

MCR Series rectifier is charge only. MCDR Series rectifier is charge/discharge and available in same current and voltage ranges as listed above. Other current and voltage ranges available on request.

CHARGE / DISCHARGE RECTIFIER FOR CONDITIONING OF TRACTION AND STATIONARY BATTERIES

CR/CDR

CR Series (charge only) are designed for tank formation or other applications which do not require discharge or reverse polarity charge.

CDR Series (charge/discharge) are designed for formation and conditioning, i.e. charging and discharging industrial batteries with at least one cycle charge, discharge, charge.

The energy is regenerated to the AC power line during discharge.

The CDR can be integrated into electrolyte circulating systems.

The number of cells or tanks per circuit or cabinet determines the maximum DC output voltage, e.g. a 320 V circuit can be connected to 110 cells or tanks in series.

Data loggers monitoring the voltage of each cell permit calculation of cell capacity.

The rectifiers are controlled by Battery Manager PC software.

Model Designation	Current [A]	Voltage [V]	Circuits per Cabinet	Number of Cells or Tanks per Circuit / Cabinet	Dimensions H x W x D [cm]	Weight approx. [kg]	Power Supply [kVA]
CDR 150-320-4	3-150	10-320	4	440	220x160x100	2400	255
CDR 200-320-2	4-200	10-320	2	220	220x160x100	1900	170
CDR 150-320	3-150	10-320	1	110	220x100x100	1100	65
CDR 200-320	4-200	10-320	1	110	220x160x100	1300	85
CDR 300-320	6-300	10-320	1	110	220x160x100	1600	130
CDR 500-320	10-500	10-320	1	110	220x160x100	2100	210
CDR 600-320	12-600	10-320	1	110	220x160x100	2400	255

Cell numbers refer to Pb cells.
CR Series rectifier is charge only. CDR Series rectifier is charge/discharge and available in same current and voltage ranges as listed above. Other current and voltage ranges available on request.

CHARGE / REVERSE CHARGE RECTIFIER FOR TACKLESS PLATE FORMATION

TCR

TCR Series (charge/reverse charge) are designed for tackless plate formation, also called dry charge formation. It features an initial charge with reverse polarity and automatic change over to normal charge.

The voltage range depends on the on-site tank installation, e.g. a circuit of 320 V can be connected to 80 tanks.

Typical current ranges are between 400 and 700 A.

The recifiers are controlled by Battery Manager PC software.

Model Designation	Current [A]	Voltage [V]	Number of Tanks	Dimensions H x W x D [cm]	Weight approx. [kg]	Power Supply [kVA]
TCR 500-120	10-500	10-120	30	220x160x100	1700	80
TCR 500-180	10-500	10-180	45	220x160x100	1800	120
TCR 500-240	10-500	10-240	60	220x160x100	1900	160
TCR 500-320	10-500	10-320	80	220x160x100	2000	210
TCR 600-120	10-600	10-120	30	220x160x100	2000	95
TCR 600-180	10-600	10-180	45	220x160x100	2100	145
TCR 600-240	10-600	10-240	60	220x160x100	2200	190
TCR 600-320	10-600	10-320	80	220x160x100	2300	255
TCR 700-320	10-700	10-320	80	220x160x100	2500	295

Tank number refers to Pb plates.
Other current and voltage ranges available on request.

RECTIFIER COMPONENTS

Circuit Controller CCT

- Single board design, containing digital regulator, firing control, pulse transformers and power supply.
- Plug-in board with automatic set-up after replacement.
- Voltage sense input to compensate for voltage drop.
- Safety shut down for all critical conditions.
- Soft start after each mode change.
- Manual or automatic restart after power interruptions.
- Reverse phase, under/over voltage protection.

Rectifier Circuit SCR

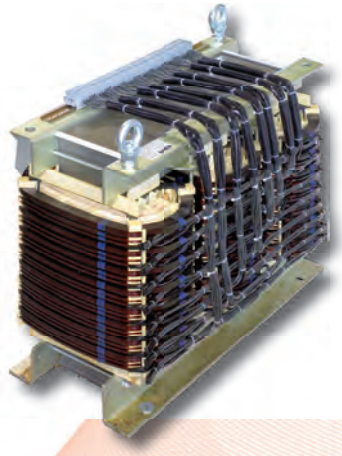
- Fully controlled six pulse three phase SCR bridge.
- Regenerative operation on discharge with energy feedback to the AC power line.
- Fuses with failure indication and safety shut down.
- Snubber network protects against transients.
- Overcurrent trip relay.
- Electronic fast switch over from charge to discharge optionally.
- Pulse formation or depolarization optionally.

Rectifier Circuit IGBT

- AC/DC switch mode IGBT bridge.
- Current output ripple less than 3% over the full range.
- Depolarization discharge capability optionally.
- Negligible harmonics to the AC power line.
- Power factor 1 over the full range.

Cabinet Controller Micro ME

- Industrial "diskless" PC communicates to each individual circuit (CCT) via CAN-Bus. High speed TCP/IP communication between host PC and all circuits.
- Critical data are backed up regularly to the host PC.
- No information loss - even if Micro ME is replaced during formation.
- Any standard monitor and keyboard can be connected directly to the Micro ME in each cabinet for service purposes.
- Circuits restart and resume automatically after a power failure.
- Logger port accepts input channels for individual cell monitoring, temperature sampling and digital I/Os.
- RS 232 for control of climatic chambers and RS 422 for additional video terminal.



SAFETY AND ENERGY BENEFITS

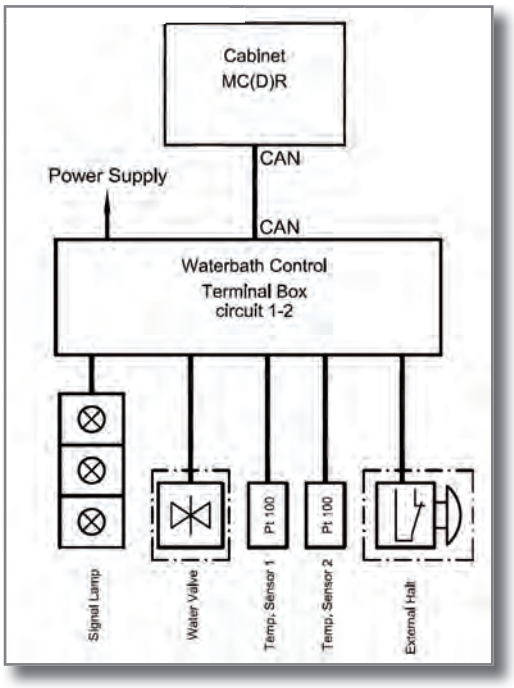
- Vacuum varnish impregnated transformers and chokes.
- Circuits electrically isolated from each other by separate secondary windings.
- Electrical performance optimized by six pulse SCR or IGBT bridges.
- Designed for 100 % utilization assuming all circuits at maximum output.
- Restricted access to all high voltage components.
- Remote HALT if the formation area's ventilation stops.
- Load free switching of main contactors.
- Overtemperature protection.
- Energy feedback to the AC power line during discharge.
- Reduced iron loss due to special transformer sheet metal.
- Special transformer design ensures balanced load across three phases.
- Calibration and maintenance service for optimum parameter settings.

Calibration Digatron 4 Service

EXTERNAL CONTROL COMPONENTS

Water Bath Control

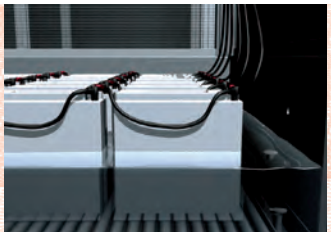
If water cooling techniques are used to enhance the dissipation of heat during formation, we recommend a water bath interface (WBI) that eliminates the need for a costly PLC controller. The WBI enclosure is typically mounted on the water bath and its interface communicates with the cabinet controller via CAN-Bus. The water bath interface monitors electrolyte temperature and the status of digital inputs and communicates these values to the cabinet controller. The cabinet controller evaluates the data and initiates the appropriate control action defined by the formation regime. Control actions include regulating charge current, opening or closing water bath valve for refill and drain and status display. The status display indicates process status by color coded lights representing the operation modes ACTIVE, INTERRUPT, and ERROR.

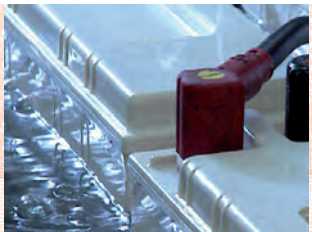


Data Logger

The data logger offers multi-channel data acquisition for single cell, battery or tank voltages. All collected data are recorded sequentially and can be used for comparison, limit evaluation, grading or sampling conditions, or for display only.

Modular by design, the data logger can be customized for each specific application. The data logger communicates via CAN-Bus with the cabinet controller.

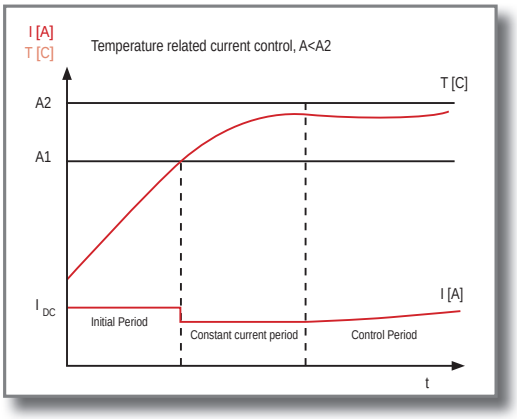


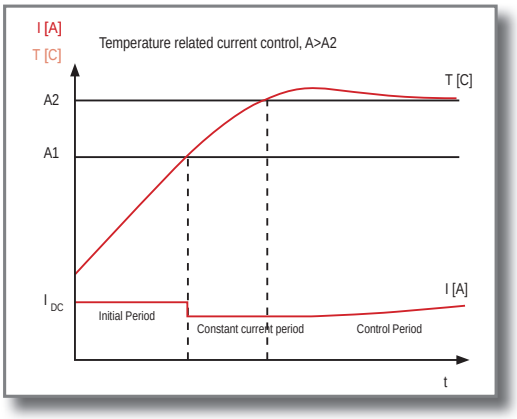


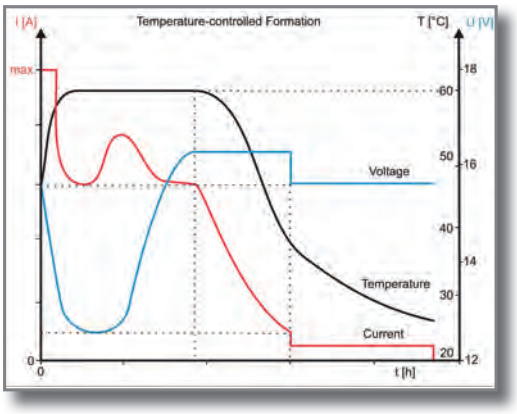
TEMPERATURE-CONTROLLED FORMATION PROCESS

Container formation of automotive and industrial batteries faces certain challenges resulting from high temperatures during the process. Dissipation of heat is limited due to low electrolyte volume, the insulating properties of the container, and the insufficient surface area available to benefit from evaporation. The most critical objective of the formation process is to maintain optimum electrolyte temperature while charging at the maximum current rate. The results will be a higher quality product, produced more efficiently in a shorter time span with minimal gassing.

Our rectifiers utilize specially developed software algorithms which consider electrolyte temperature, battery voltage, formation current, and total charge (Ah) simultaneously as process control parameters in a three-step formation program.







Initial period

After starting the formation process, batteries are charged with the programmed constant current I_{DC}. During this period, temperature increases.

If the electrolyte temperature of the pilot batteries exceeds the programmed temperature limit A1, the charging current will be reduced.

Constant current period

During the constant current period the negative or positive temperature gradient is evaluated.

If the temperature exceeds the programmed limit temperature A2, or if the temperature gradient becomes zero, the system starts the control period.

Control period

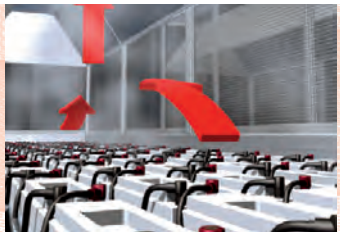
During the control period the system uses the temperature to regulate the charging current I_{DC}. This may result in increasing or decreasing the charging current.

This 3-stage formation process ensures maximum utilization of the charging rectifier while maintaining electrolyte temperature within an acceptable range.

Step Number	Operator	Nominal Value	Termination	Abort	Registration
1	SET	77.0 C < 75.0 C > 0.3 C			
2	PAUSE		10.0 min	< 45.0 C	
3	CHARGE	60.0 A	3:00:00 h		
4	STOP				

Program Editor

The Program Editor of the Battery Manager formation software can be used to define the factor of current reduction applied to the constant current period and to define the temperature limits. Dynamic regulator parameters similar to PID can be entered into the editor to adapt the formation process environment.



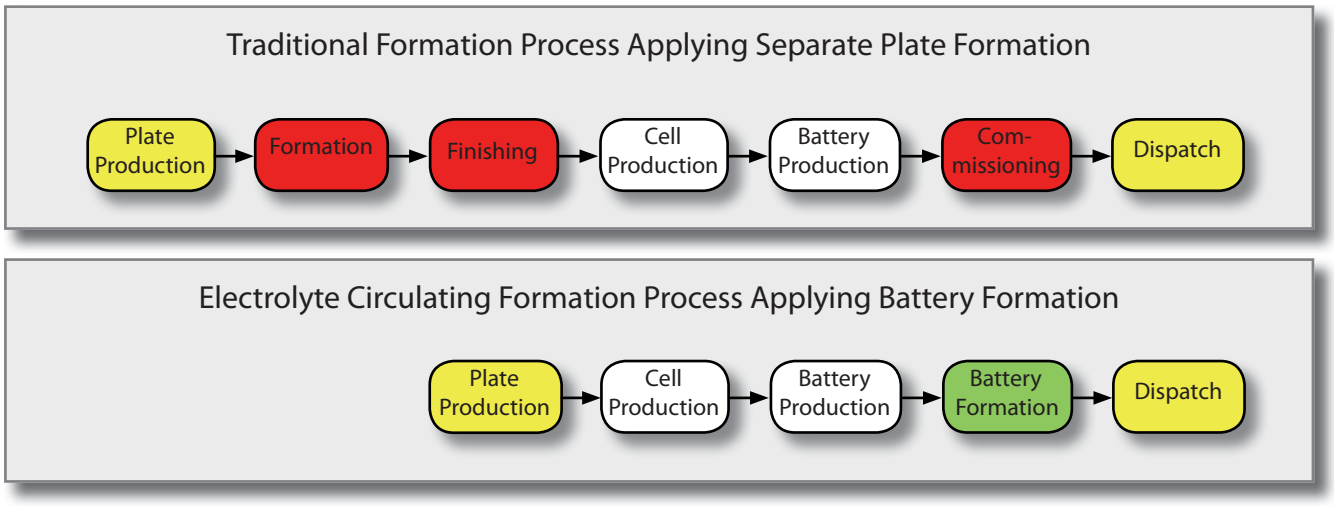
ELECTROLYTE CIRCULATING FORMATION PROCESS

Electrolyte circulating formation processes are mainly applied to traction or stationary batteries to considerably reduce their formation time by means of acid cooling. During the formation process, precise adjustment of acid density improves the process reproducibility and product quality. Only raw sulfuric acid and deionized water are required. Waste water is not generated and excess electrolyte is reused for the next batch.

Digatron offers specific charge/discharge rectifiers that communicate with the supervising PC of the electrolyte circulating system and allow to handle the respectively high currents.

Digatron can integrate formation rectifiers with electrolyte circulating modules for a turn-key installation including:

- Acid buffer
- Acid mixing
- Acid filling
- Electrolyte cooling without energy consumption
- Droplet separator
- Process control with acid density and temperature control
- Leakage and flow control
- Electrolyte circulating using special cell adapter



BATTERY MANAGER FORMATION SOFTWARE

The All-In-One Software Solution

The knowledge of a worldwide company with over 40 year's experience in the battery industry has been incorporated in Battery Manager - the battery testing and formation software solution developed by Digatron. It provides enhanced formation process efficiency by connecting all Digatron devices, as well as external devices such as temperature chambers, water baths or densitiy meter to one common database.

Battery Manager is a stable Windows XP based software that has networking capability to control circuits from various workstations. All recorded data collected from the formation process is stored in a Microsoft SQL server database. The data can be used to create an unlimited number of management and production reports by using third-party software like "Crystal Reports". Battery Manager software modules are accessible via a shortcut bar and described hereafter.

Floor View

- Offers a graphical representation of the formation area. Features like walls, doors, windows, etc. can be used to give an accurate representation of the formation area.
- Provides a general overview over the formation process and complete control of the circuits (each small colored box represents one charging circuit, whereas the color indicates the circuit's status (charging, discharging, error, end of formation, etc).
- If the cursor is placed over one of the circuits, a quick view window pops up to show further status details (location, status, battery type, amps, volts, temp and total amp hours).
- Double-clicking a circuit opens a split screen window which contains detailed information on the formation process including: the Quick View window, the running schedule, and the Data View window that depicts all formation process data in tabular and graphical formats. The Data View can be customized to show various parameters such as voltage, current, amp hours, temperature, etc.

Status View

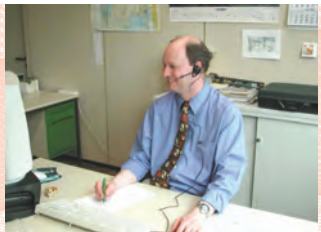
- Gives a complete listing of all circuits in a spread sheet format. Columns can be customized and sorted by ascending or descending values.
- Multiple status views can be opened at one time.
- Supports viewing options by writing simple filters: "Snapshot" filters show circuits that match the criteria at the time the filter is applied. "Continuous" filters update the display each time the status of the circuits changes.
- Direct control of all charging circuits (start, stop, break, continue). The operator only needs to know the circuit number and battery type to start a circuit.

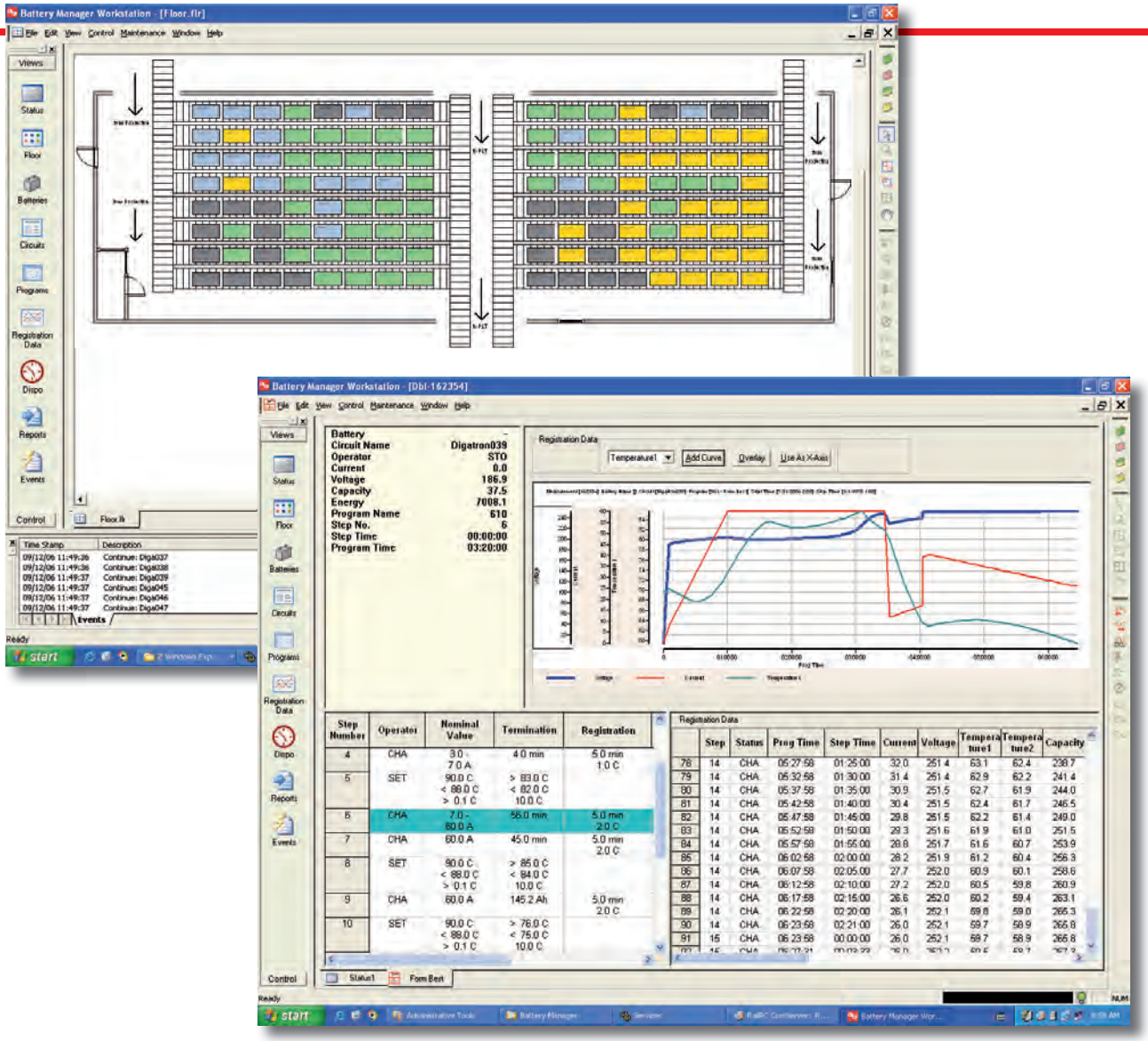
Program Editor

- For creating new formation programs as well as viewing, editing, and deleting existing programs.
- Handling similar to Windows Explorer.
- Visualization of a program's function in a diagram.
- Registration format can be defined for each program step.

Battery View

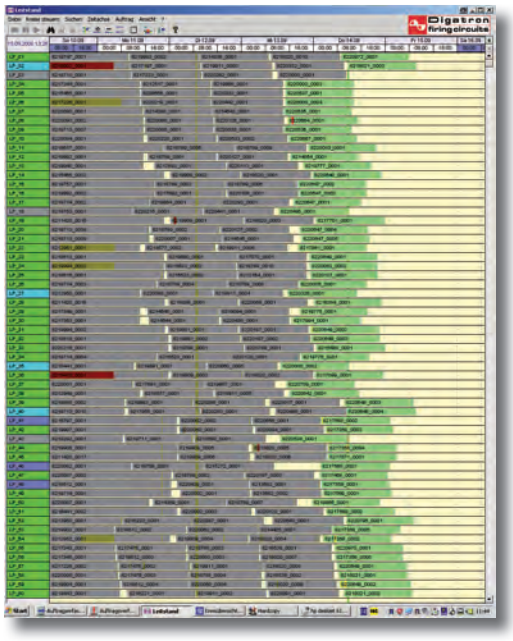
- For defining battery types.
- General details such as capacity, voltage, number of cells, etc. are listed in the top box.
- The lower box is used to link the battery type to a formation program.





Add-on: Capacity Planning System

- Optimizes the efficiency of test and formation schedules considering process requirements and the proximity of equipment to the product to be processed.
- In-process and scheduled jobs are clearly displayed on a freely-scalable time axis.
- Provides an interface to receive and transmit relevant job data from other job management systems such as SAP.



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