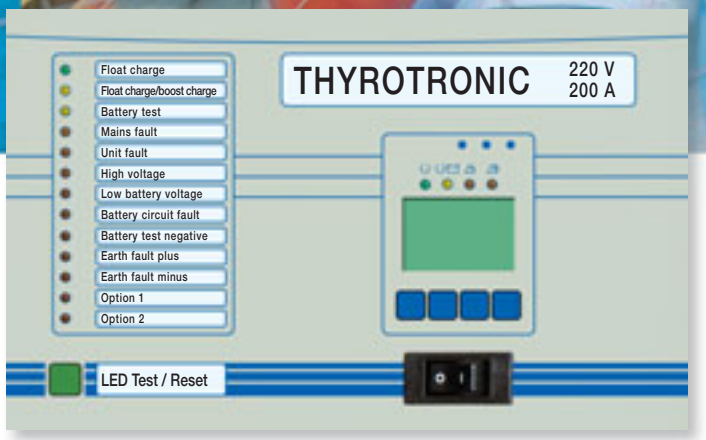
BENNING

World Class Power Solutions



Rectifiers

for stationary battery systems

Standard thyristor-controlled rectifiers

THYROTRONIC Line

THYROTRONIC rectifier range for stationary back up power supply

General

The protection of electrical load against power failure is often carried out by battery backed up DC power supplies, providing electrical energy to important loads during mains supply, as well as during mains failure.

Fig. 1: Thyrotronic

Battery backed up DC power supplies have, over several decades proved extremely reliable and very economical power supplies.

The reliability of a battery backed up DC power supply is defined by the quality of the battery used, as well as the reliable operation of the rectifier.

Range of applications

- **Power plants**
- **substations**
- **Railway equipment**
- **Offshore projects**
- **Oil and gas pipeline systems**
- **hospitals**

The Thyrotronic rectifier range (see picture 1) developed by Benning is especially qualified for use as battery backed up power supplies and feature very high reliability and a comprehensive monitoring concept.

Thyrotronic rectifiers are operating with a controlled output characteristic (IU-characteristic line in accordance with DIN 41773).

The output voltage is kept constant to the set value with a permissible deviation of ± 0,5 % within a load range between 0 % and 100 % of the unit current.

Mains voltage fluctuations of ± 10 % and mains frequency fluctuations of ± 5 % will be controlled automatically.

As an energy storage mainly closed or vented lead acid batteries are used. Nickel-cadmium batteries are used in extreme ambient conditions.

Type table THYROTRONIC
rectifier range for multi-purpose use

Nom. voltage [V]	No. of cells Pb	No. of cells NiCd	Output Current [A]	Type		Mains voltage [V]	Current consump. [A]	Cabinet type	Weight [kg]
24	12	20	20	E 230 G 24 / 20	BWrug-TDG	230	4,6	WGZ 755	30
24	12	20	40	E 230 G 24 / 40	BWrug-TDG	230	9,2	WGZ 755	40
24	12	20	60	E 230 G 24 / 60	BWrug-TDG	230	13,6	PSJ 1564	60
24	12	20	80	E 230 G 24 / 80	BWrug-TDG	230	17,8	PSJ 1564	75
24	12	20	100	D 400 G 24 / 100	BWrug-TDG	3 x 400	5,5	PSJ 1564	150
24	12	20	125	D 400 G 24 / 125	BWrug-TDG	3 x 400	6,8	PSJ 1564	200
24	12	20	160	D 400 G 24 / 160	BWrug-TDG	3 x 400	8,7	PSJ 1564	240
24	12	20	200	D 400 G 24 / 200	BWrug-TDG	3 x 400	10,8	PSJ 1564	290
24	12	20	300	D 400 G 24 / 300	BWrug-TDG	3 x 400	19,0	PSJ 1564	400
24	12	20	400	D 400 G 24 / 400	BWrug-TDG	3 x 400	24,3	PSJ 1596	510
48	24	40	10	E 230 G 48 / 10	BWrug-TDG	230	4,6	WGZ 755	30
48	24	40	20	E 230 G 48 / 20	BWrug-TDG	230	9,1	WGZ 755	40
48	24	40	30	E 230 G 48 / 30	BWrug-TDG	230	12,3	PSJ 1564	60
48	24	40	40	E 230 G 48 / 40	BWrug-TDG	230	16,3	PSJ 1564	75
48	24	40	50	D 400 G 48 / 50	BWrug-TDG	3 x 400	5,8	PSJ 1564	145
48	24	40	60	D 400 G 48 / 60	BWrug-TDG	3 x 400	6,7	PSJ 1564	190
48	24	40	80	D 400 G 48 / 80	BWrug-TDG	3 x 400	8,9	PSJ 1564	220
48	24	40	100	D 400 G 48 / 100	BWrug-TDG	3 x 400	10,8	PSJ 1564	270
48	24	40	125	D 400 G 48 / 125	BWrug-TDG	3 x 400	13,8	PSJ 1564	290
48	24	40	160	D 400 G 48 / 160	BWrug-TDG	3 x 400	17,6	PSJ 1564	340
48	24	40	200	D 400 G 48 / 200	BWrug-TDG	3 x 400	21,9	PSJ 1866	400
48	24	40	300	D 400 G 48 / 300	BWrug-TDG	3 x 400	32,0	PSJ 1866	500
48	24	40	400	D 400 G 48 / 400	BWrug-TDG	3 x 400	48,0	PSJ 1896	600
60	30	50	10	E 230 G 60 / 10	BWrug-TDG	230	5,1	WGZ 755	30
60	30	50	20	E 230 G 60 / 20	BWrug-TDG	230	10,3	WGZ 755	40
60	30	50	30	E 230 G 60 / 30	BWrug-TDG	230	17,5	PSJ 1564	60
60	30	50	40	E 230 G 60 / 40	BWrug-TDG	230	20,4	PSJ 1564	75
60	30	50	50	D 400 G 60 / 50	BWrug-TDG	3 x 400	6,8	PSJ 1564	150
60	30	50	60	D 400 G 60 / 60	BWrug-TDG	3 x 400	8,1	PSJ 1564	220
60	30	50	80	D 400 G 60 / 80	BWrug-TDG	3 x 400	10,8	PSJ 1564	250
60	30	50	100	D 400 G 60 / 100	BWrug-TDG	3 x 400	13,5	PSJ 1564	280
60	30	50	125	D 400 G 60 / 125	BWrug-TDG	3 x 400	17,1	PSJ 1564	300
60	30	50	160	D 400 G 60 / 160	BWrug-TDG	3 x 400	21,7	PSJ 1564	350
60	30	50	200	D 400 G 60 / 200	BWrug-TDG	3 x 400	26,5	PSJ 1866	420
60	30	50	300	D 400 G 60 / 300	BWrug-TDG	3 x 400	40,5	PSJ 1866	520
60	30	50	400	D 400 G 60 / 400	BWrug-TDG	3 x 400	53,0	PSJ 1896	620
108	54	90	5	E 230 G 108 / 5	BWrug-TDG	230	4,0	WGZ 755	30
108	54	90	10	E 230 G 108 / 10	BWrug-TDG	230	8,0	WGZ 755	40
108	54	90	16	E 230 G 108 / 16	BWrug-TDG	230	13,2	PSJ 1564	60
108	54	90	25	D 400 G 108 / 25	BWrug-TDG	3 x 400	6,5	PSJ 1564	75
108	54	90	30	D 400 G 108 / 30	BWrug-TDG	3 x 400	7,5	PSJ 1564	95
108	54	90	40	D 400 G 108 / 40	BWrug-TDG	3 x 400	10,0	PSJ 1564	180
108	54	90	50	D 400 G 108 / 50	BWrug-TDG	3 x 400	12,9	PSJ 1564	220
108	54	90	60	D 400 G 108 / 60	BWrug-TDG	3 x 400	14,7	PSJ 1564	260
108	54	90	80	D 400 G 108 / 80	BWrug-TDG	3 x 400	20,0	PSJ 1564	330
108	54	90	90	D 400 G 108 / 100	BWrug-TDG	3 x 400	24,7	PSJ 1866	400
108	54	90	125	D 400 G 108 / 125	BWrug-TDG	3 x 400	31,5	PSJ 1866	450
108	54	90	160	D 400 G 108 / 160	BWrug-TDG	3 x 400	40,0	PSJ 1866	500
108	54	90	200	D 400 G 108 / 200	BWrug-TDG	3 x 400	50,0	PSJ 1896	520
108	54	90	300	D 400 G 108 / 300	BWrug-TDG	3 x 400	70,0	PSJ 1896	850
108	54	90	400	D 400 G 108 / 400	BWrug-TDG	3 x 400	100,0	PSJ 2288	1100
216	108	180	5	E 230 G 216 / 5	BWrug-TDG	230	9,4	WGZ 755	40
216	108	180	10	D 400 G 216 / 10	BWrug-TDG	3 x 400	5,1	PSJ 1564	60
216	108	180	16	D 400 G 216 / 16	BWrug-TDG	3 x 400	8,0	PSJ 1564	80
216	108	180	20	D 400 G 216 / 20	BWrug-TDG	3 x 400	9,8	PSJ 1564	120
216	108	180	25	D 400 G 216 / 25	BWrug-TDG	3 x 400	12,4	PSJ 1564	220
216	108	180	30	D 400 G 216 / 30	BWrug-TDG	3 x 400	15,2	PSJ 1564	260
216	108	180	40	D 400 G 216 / 40	BWrug-TDG	3 x 400	21,0	PSJ 1564	330
216	108	180	50	D 400 G 216 / 50	BWrug-TDG	3 x 400	25,2	PSJ 1866	400
216	108	180	60	D 400 G 216 / 60	BWrug-TDG	3 x 400	30,5	PSJ 1866	450
216	108	180	80	D 400 G 216 / 80	BWrug-TDG	3 x 400	40,0	PSJ 1866	500
216	108	180	100	D 400 G 216 / 100	BWrug-TDG	3 x 400	50,0	PSJ 1896	620
216	108	180	125	D 400 G 216 / 125	BWrug-TDG	3 x 400	63,0	PSJ 1896	720
216	108	180	160	D 400 G 216 / 160	BWrug-TDG	3 x 400	81,0	PSJ 1896	800
216	108	180	200	D 400 G 216 / 200	BWrug-TDG	3 x 400	100,0	PSJ 2288	1050
216	108	180	300	D 400 G 216 / 300	BWrug-TDG	3 x 400	152,0	PSJ 221208	1300
216	108	180	400	D 400 G 216 / 400	BWrug-TDG	3 x 400	203,0	PSJ 221208	1600

Subject to technical change without notice, other types on request.

THYROTRONIC
rectifier range for multi-purpose use

Operation

Lead-acid and nickel-cadmium batteries achieve optimum service life when remaining on float, in a charged condition. The charger floats the battery in a charged state and also supplies the load with power. In the event of mains power failure the battery will then supply the load its required power. This is called "parallel operation" (see fig. 2).
With substantially discharged batteries, the rectifier unit at first operates in the I-branch of the IU-characteristic line, whereby the charging current for the batteries results from the difference between the nominal current of the rectifier unit and the load current.
When the set output voltage of the rectifier unit (U-branch) has been reached, the unit is changed to constant voltage charging (see fig. 3).

Switching the charge characteristic, from float charging (e.g. 2.23 V/cell with lead-acid batteries) to boost charging (2.4 V/cell with lead-acid batteries) gives an accelerated recharge which can be manual, dependent on voltage or dependent on voltage and time.

After the battery has been fully charged, a small charge current flows (approx. 0.3 mA to 1 mA per 1 Ah) to balance the internal losses of the battery.

The required autonomy is taken into consideration for calculating the battery size. The standby times vary depending on type of load and mains conditions.

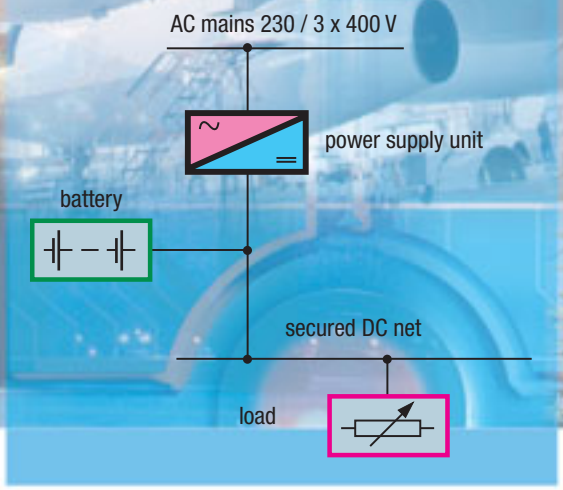


Fig. 2: Standby parallel operation

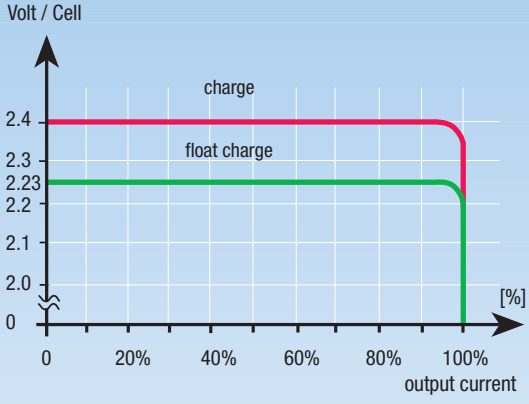


Fig 3: Charging characteristic for lead-acid batteries in accordance with DIN 41773

Typical values: Depending on type of load and mains conditions

- **10 - 30 minutes**
  - **for EDP-systems**
- **1 - 3 hours**
  - **energy supply**
  - **process control**
  - **rail way**
  - **air ports**
  - **hospitals**
- **2 - 10 hours**
  - **telecommunication systems**
  - **oil and gas industry**

THYROTRONIC
safe, reliable, powerful

Fig. 4 Thyrotronic interior view

Rectifier series Thyrotronic

The Thyrotronic series consists mainly of a thyristor-controlled power unit and a microprocessor-controlled monitoring and control unit.

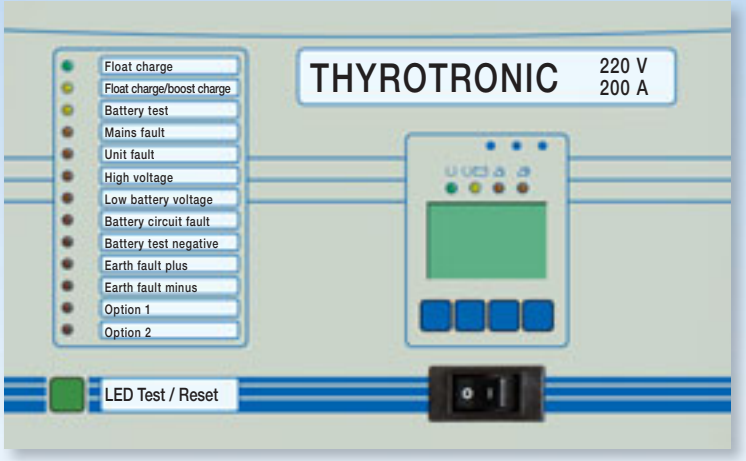
The following main components are included:

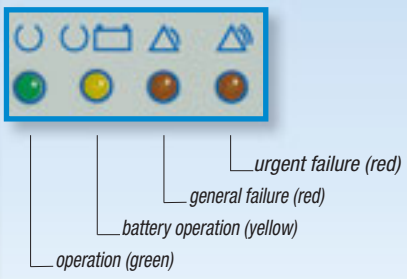
- **mains input with contactor**
- **mains transformer with separate windings**
- **fully controlled 6 pulse three phase bridge with semi conductor protection fuse (working primarily as battery inverse polarity protection)**
- **smoothing chokes and capacitor bank to reduce ripple**
- **control unit with digital setpoint setting**
- **digital monitoring**
- **display and operation unit with graphical LCD display on the front door (see picture 5)**
- **NH fuse loaded battery circuit breakers**
- **2 pol NH load circuit breaker to be populated with fuses or links for load circuit**

Display and operation unit (see picture 5)

The display and operation unit mounted on the front door of the Thyrotronic features a graphical LCD display to indicate the status and the measurements in plain text, as well as 17 LED's controlled by the monitoring and control unit.

The 4 LED's integrated in the display above the push buttons are linked to fixed functions
Two spare LED's can be linked to any external monitoring units.





THYROTRONIC
comprehensive alarm and monitoring concept

Functions of the signalling and monitoring unit:

In the rectifiers of the Thyrotronic range a very large monitoring concept with the following functions is included as standard:

Mains monitoring

In case of a mains failure , an electronic regulator block is initiated and the LED and the "mains failure relay " will be activated. If the mains voltage returns the unit is automatically switched on after a set time.

Charger output monitoring

The charger output monitoring is a current-dependent low voltage monitoring and monitors the IU-characteristic of the rectifier unit.
If the charger output falls below a set value of 2,1 V/cell and the output current falls below 90 % of the rated current the alarm will activate and indicate "unit fault". The corresponding LED and the common relay will be activated.

High voltage monitoring

If the output voltage rises too high (value is adjustable) due to an internal or external interference, over 20 msec, the impulse blocking will be activated and the output voltage will be set to zero.
This high voltage monitoring works as dynamic monitoring with an automatic reset. If the monitoring activates 4 times within a period of 30 seconds, the mains contactor will be disconnected, the LED "high voltage" and common relay will be activated.

Low battery voltage

If the battery voltage falls below a set value, e.g. 1,8 V/cell (value adjustable) during discharge in a case of mains failure, the alarm "low battery voltage" will appear. LED and common alarm will be activated.

Battery circuit test

The battery circuit of the power supply system is tested cyclically every 24 hours. For this, the rectifier output voltage is dropped down to 1.9 V/C for a period of 5 secs. and, as a result, the battery is discharged. At the same time, the battery voltage is checked. If the battery voltage stays above 1.9 V/C, the battery circuit has no fault. If it falls below the limiting value, a "battery circuit fault" will be indicated and the LED as well as the common fault signalling relay will be activated. - **Caution!** - It is not intended that this test should replace battery circuit monitoring!

Battery availability test

During the battery availability test the rectifier output voltage will be dropped and the battery will be discharged as is the case during the battery circuit test. The battery will be discharged down to an adjustable minimum voltage limit during an adjustable time. These limits depend on the proportional battery capacity withdrawn during the discharge and can be taken from the discharging curves of the connected battery.
If, during the availability test, the values fall below the adjusted limits, the message "battery test negative" will be indicated by the corresponding LED and the common fault signalling relay.
After the test the rectifier automatically switches back to boost charge or floating charge.

Earth fault monitoring

The earth fault monitoring function monitors the insulation resistance of the DC-output to earth. Plus and minus are measured and monitored alternately. If the insulation resistance falls below the adjusted value (adjustable from 100 kOhm to 1 MOhm), this will be indicated by the LEDs and the common alarm.

I*R Compensation

With I*R Compensation it is possible to compensate for the voltage drop on the cable between rectifier and battery by entry of cable length and cross-section of the cable.

Programmable float/boost charge change over

If the battery voltage lowers due to mains failure or any other circumstances the rectifier unit will work in current limit. If it operates for more than 30 seconds after the charge start it will automatically be switched over to boost charge characteristic. After the boost charge voltage (current limitation) has been reached and after decreasing to < 90 %, a time stage will be activated. Upon expiry of the set time (0 to 6 h) it will automatically be switched back to float charge.

The automatic charging can be switched off so that only a manual switch-over via the plastic foil key board on the front panel is possible. Switching back to float charge can be done manually as well. If this is not done, the controller will switch back as in the case of automatic charging.

The switch-over to boost charge can be blocked by an external contact or a fixed bridge on the controller.

Equalise charge stage

It is possible to switch to an equalise charge stage via a switch on the front panel.
Here the voltage limitation will be abolished and the nominal unit current will be reduced to 20 % (adjustable from 20-30). An equalise and commissioning charge follows with an I-characteristic up to the final charge voltage of the battery.

After switching to equalise charge, a timer automatically switches back to the float charge on expiry of the set time (16 hours to 72 hours).
Using an external contact or a fixed bridge at the regulator, the equalise charge can be blocked and a switch over to the I-characteristic can be prevented.

Load sharing in parallel operation

Due to an internal bus connection between several rectifiers an active load sharing of ± 10 % is possible.

THYROTRONIC
technical data

Technical data

Mains input		
Input voltage	(VAC)	230 ± 10% 1-phase 3x400 ± 10% 3-phase
Input current	(A)	see type table
Frequency	(Hz)	50 ±5%
Power factor		~0.83 at nominal mains voltage and float charging

Rectifier output		
Output voltage	(VDC)	24, 48, 60. 110,125,220
Output current	(A)	see type table
Output current adjustment range	(%)	50 – 100 rectifier current limit
	(%)	0 - 50 battery charging current limit
Current accuracy	(%)	± 2
Characteristic		IU in acc. DIN41773 @ float and boost
Boost voltage	(V/C)	2,4 lead acid battery 1,55 NiCd Batterie
Float voltage	(V/C)	2,23 lead acid battery 1,40 NiCd battery
Equalize voltage	(V/C)	2,7 lead acid battery 1,7 NiCd battery with reduced current
Output Voltage adjustment range	(%)	±5
Voltage accuracy	(%)	± 0,5
Ripple	(%)	< 5 rms eff. without battery option < 2 rms without battery
Efficiency	(%)	85 – 94% type dependent

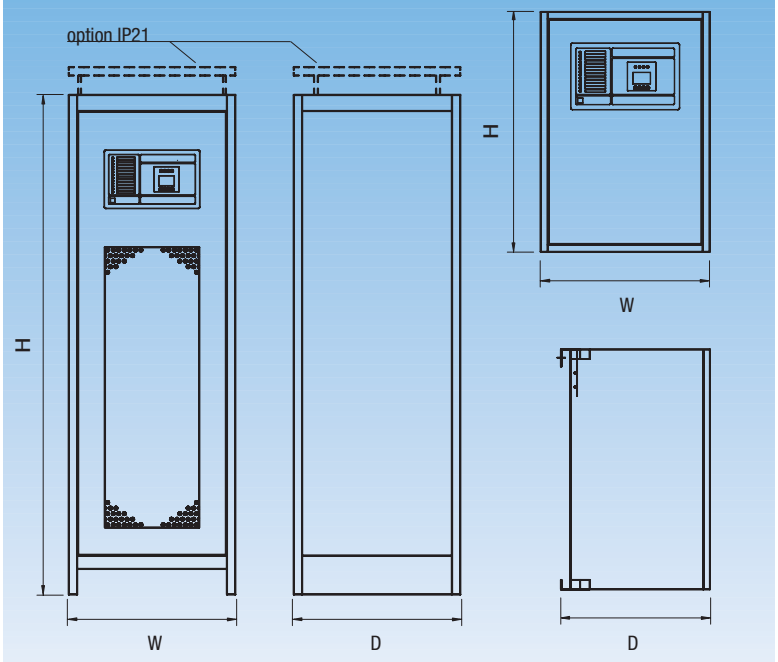
General data		
EMC		EN 61000-6-2, EN 61000-6-3
Rel. humidity	(%)	< 95 non condensing
Audible noise	(dB A)	< 65 measured at 1m distance and half rectifier height
Installation height	(m)	max. 1000 above sea level
	(m)	max. 2000 above sea level with decrease to 92% I nominal
Cooling		natural convection
Ambient temperature	(°C)	0 – 40 with 100% I nominal 0 – 50 with 88% I nominal
Storage temperature	(°C)	- 20 to +70
Cabinet protection		IP 20 IEC60529
Cabinet		Steel frame floor standing cabinet, front door with double bit lock
Paint finish		RAL 7035 structured powder coating
Volt free alarms		mains failure battery voltage low common alarm

Options	
Interfaces	MOD Bus Profibus additional relaycontacts
Higher IP protection	
Countercells	
Analogue measuring instruments	
Additional monitoring components	

Cabinet type table

Cabinet type	Dimensions (mm)		
	H	W	D
WGZ 755	758	534	470
PSJ 1564	1500	600	400
PSJ 1566	1500	600	600
PSJ 1866	1800	600	600
PSJ 1896	1800	900	600
PSJ 2288	2200	800	800
PSJ 221208	2200	1200	800

WGZ - wall mounted cabinet
PSJ - floor standing cabinet



PSJ - floor standing cabinet

WGZ - wall mounted cabinet

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