Wing Battery
Installation
&
Maintenance Manual

TABLE OF CONTENTS

1 Safety

- Read the installation and operating instructions.
- No smoking.
- Always wear protective rubber gloves, glasses and clothing (incl. safety shoes).
- Even when disconnected, a battery remains charged. The metallic parts of a battery are electrically active.
- Always use isolated tools.
- Never place tools on batteries (in particular, metallic parts can be dangerous).
- Check torques in case of unsecured screw connections of inter-cell and inter-block connectors.
- Never pull up or lift cells / blocks at the terminals.
- Avoid impacts or sudden jolts.
- Never use synthetic clothes or sponges to clean the cells / blocks.
- Use water only (damp clothes) without solvents or additives.
- Avoid naked flames, electrostatic charges and discharges/sparks.

2 Definitions

2.1 Float Charging

Float charging is a constant voltage charge applied to the battery ensuring it remains fully charged in standby applications.

- @20˚C: the voltage is 2.29 V/Cell.
- @25˚C: the voltage is 2,27 V/Cell.
- No current limit.
- In order to maximise the service life of the battery in higher or lower operating temperature conditions, it is recommended the float voltage be adjusted. Should the ambient temperature adjacent to the battery installation be higher than 25˚C or lower than 20˚C, the charging voltage per cell should be adjusted accordingly:
  - >25˚C: Charging Voltage = 2.27 V/Cell – (0.003 V * DT) (DT = difference to 25˚C).
  - <20˚C: Charging Voltage = 2.29 V/Cell + (0.003 V * DT) (DT =difference to 20˚C).

Operational Temperature	Temperature compensated charge voltage per cell
0˚C	2,350 V/Cell
5˚C	2,335 V/Cell
10˚C	2,320 V/Cell
15˚C	2,305 V/Cell
20˚C	2,290 V/Cell
25˚C	2,270 V/Cell
30˚C	2,255 V/Cell
35˚C	2,240 V/Cell
40˚C	2,225 V/Cell

2.2 Equalization Charging

Equalization charging is a defined charge to ensure all the active material has been completely converted in all cells. An equalization charge is necessary to boost or balance a battery block or string when:

- The battery has been float charged without discharge for greater than 12 months.
- The internal resistance of battery blocks in a string have increased by >35% (see chapter 6.5).
- The battery block or battery string has been subject to low ambient temperature operation below 20˚C without compensation of the float voltage.
- Frequent discharges with short recharge times <72 hrs.
- Long delays in recharging >48 hrs after battery discharge.
- Uneven battery block voltages in a string.
- Uneven paralleled battery string voltages.

- The equalization charge should be applied with a voltage of 2,4 V/Cell for 8-12 hours and monitored throughout the equalization period. Charging current should be limited to C/3 i.e. nominal battery block capacity (Ah) / 3.
- In the event that the battery temperature increases by more than 5˚C during the equalization charge or a strong odor permeates from any battery block(s) in the string, stop charging immediately and contact your local Wing representative for advice.

3 Storage

- The storage time should be as short as possible.
- Appropriate inventory turnover based on a FIFO-method (“First In – First Out”) avoids over-storage.
- Protect the cells / blocks from harsh weather, moisture and flooding.
- Protect the cells / blocks from direct or indirect sun radiation.
- The storage area should be clean, dry and frost-free.
- Cells / blocks must be protected from short-circuits caused by metallic parts or conductive contaminants.
- Cells / blocks must be protected from falling objects or debris.
- Avoid the stacking of battery pallets.
- Avoid storing of unpacked cells / blocks on uneven or sharp-edged surfaces.
- It is recommended to ensure the same storage conditions within a batch, pallet or room.
- Storage time:
  - Maximum recommended storage time without recharging @20˚C is 6 months.
  - For ESL, ESL FT and ESL FTHT the recommended storage time is 12 months at a temperature of up to 30˚C.
  - Required open circuit voltage (OCV) checks during storage.
  - Equalization charging is necessary if the OCV is below 2,11 V/Cell => 12,66 V/Block.
  - @20˚C: after 6 months, then every 3 months.
  - @30˚C: after 4 months, then every 2 months.
  - If the OCV is below 2,11 V/Cell perform a equalization charge (see chapter 2.2 'Equalization Charging').

4 Battery Assembly

4.1 Battery Room

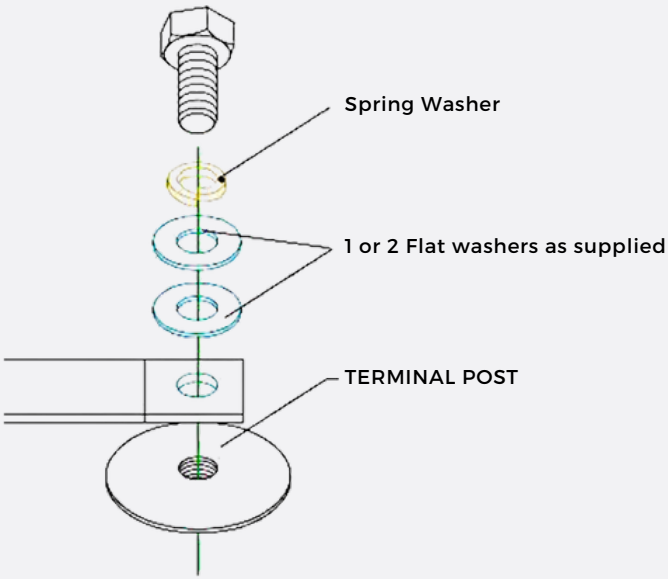
- Room temperature should ideally be between +10˚C and +30˚C.
- Optimal temperature is between +20˚C and +25˚C.
- Lower temperatures decrease battery capacity.
- Higher temperatures decreases battery life expectation.
- Ventilation should be provided according to EN IEC 62485.
- Do not install batteries in sealed rooms.
- The battery room should be clean and dry.

4.2 Preparation

- Check boxes or packaging for external damage.
- Unpack the batteries and check for any signs of damage to the battery cases.
- Check the correct polarity of the battery blocks and measure the OCV at each block. The OCV should be above 2,11 V/Cell => 12,66 V/Block. If not recharge as per chapter 2.2 'Equalization Charging'.

4.3 Installation

- Use insulated tools for assembly.
- Wear rubber gloves, protective clothing and protective glasses.
- Remove all metallic objects i.e. watches, jewellery etc.
- Place the batteries in the Battery-Rack or Cabinet according to the Installation plan.
- Batteries should be installed with a minimum air gap.
- Free space must be provided between each battery block. The recommended distance is 10 mm. The minimum distance is 5 mm.
- The installation must be carried out with the supplied original accessories in the following order: terminal post, connector, flat washer, spring washer and terminal bolt (see graphic next page).



- Terminal grease should be applied to the terminal assembly to prevent any possible oxidation or corrosion inhibiting future maintenance or replacement.
- The screw connection should be tightened to the torque recommended on the data sheet or battery label for each battery type.
- Connect the positive (+) terminal of battery block N°1 to the positive (+) terminal of the charger, transition box or battery string connection unit.
- Connect the negative (-) terminal of battery block N°1 to the positive (+) terminal of battery block N°2.
- Connect the negative (-) terminal of battery block N°2 to the positive (+) terminal of battery block N°3.
- Follow this procedure for each battery block in the serial string.
- Connect the negative (-) terminal of the last battery block to the negative (-) terminal of the charger, transition box or battery connection unit.
- If you have multiple strings follow the instruction above for each string.
- Check the overall battery string voltage. It should comply with the number of battery blocks in series.
- The connecter cable for positive (+) and negative (-) connection must have the same length for each string.
- You must have at least one fuse or circuit breaker in order to isolate each battery string.

5 Operation

- After connection a float charge voltage needs to be applied (see chapter 2.1 'Float Charging'). The float voltage should correlate with the ambient temperature as shown in the table.
- @20˚C: the voltage is 2.29 V/Cell (+/-1%).
- @25˚C: the voltage is 2.27 V/Cell (+/-1%).
- The float voltage should be recorded immediately after being applied to the battery string(s).
- After the float charge has been applied the battery string(s) should be allowed to charge for 48hrs prior to being connected to the load.
- Prior to connecting to the load recheck the float voltage and record the reading.
- Should the ambient temperature adjacent to the battery installation be higher than 25˚C or lower than 20˚C, the charging voltage should be adjusted accordingly:
  - >25˚C: Charging Voltage = 2.27 V/Cell – 0.003 V · DT (DT = difference to 25˚C).
  - <20˚C: Charging Voltage = 2.29 V/Cell + 0.003 V · DT (DT =difference to 20˚C).

Operational Temperature	Temperature compensated charge voltage per cell
0˚C	2,350 V/Cell
5˚C	2,335 V/Cell
10˚C	2,320 V/Cell
15˚C	2,305 V/Cell
20˚C	2,290 V/Cell
25˚C	2,270 V/Cell
30˚C	2,255 V/Cell
35˚C	2,240 V/Cell
40˚C	2,225 V/Cell

- Maximum charging current:
  - Float charging: no current limit.
  - Equalization charging: current limited to C/3 (e.g. 100 Ah => 30 A) (see chapter 2.2 'Equalization Charging').

6 Maintenance

6.1 Battery care

- The battery system is to be kept clean and dry as to avoid any stray current leakage or tracking.
- For cleaning, use a cloth moistened in a solution of bicarbonate of soda and water or just plain water. Do not use cleaners of unknown solutions such as window or glass cleaners and solvents.

6.2 Inspection every 6 months

- Visual inspection of batteries for cleanliness, terminal damage, container or cover damage and evidence of overheating.
- Check and record float charge voltage of the battery system and of each individual battery block. Adjust as necessary (see chapter 2.1 'Float Charging').
- Check and record the surface temperature of the battery blocks using the Battery Log Sheet pages 10 & 11.
- Check and record the ambient temperature. If the ambient temperature adjacent to the battery string(s) is found to be <20˚C or >25˚C and no temperature compensated float charging has been applied then adjust the charge voltage as per the table in chapter 2.1 Float Charging.
- When single battery blocks show a block voltage deviation of +0,49 V/-0,24 V per block from the set float for the system perform an equalization charge (see chapter 2.2 'Equalization Charge').

6.3 Inspection every 12 months

- All connection hardware should be torqued to the value indicated on the battery label or in the data sheet with a calibrated torque wrench.
- Visual inspection of batteries for cleanliness, terminal damage, container or cover damage and evidence of overheating.
- Check and record float charge voltage of the battery system and of each individual battery block. Adjust as necessary (see chapter 2.1 'Float Charging').
- Check and record the surface temperature of the battery blocks.
- Check and record the ambient temperature. If the ambient temperature adjacent to the battery is found to be <20˚C or >25˚C and no temperature compensated float charging has been applied then adjust the charge voltage as per the table in chapter 2.1 Float Charging.

- When single blocks show a block voltage deviation of +0,49 V/-0,24 V per block from the set float for the system perform a equalization charge (see chapter 2.2 'Equalization Charge').

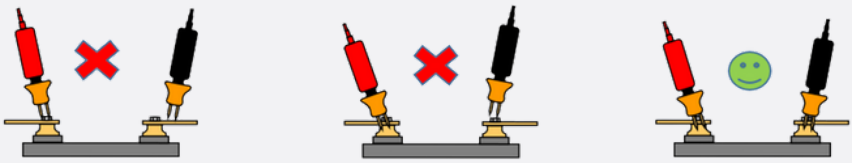
6.4 Periodic discharges

- Periodic discharges can be used to detect faulty battery blocks and ageing symptoms of the battery system in order to consider battery replacement in good time.
- Periodic discharge tests are ideally recommended every 24 months after installation for the first 6 years of service then every 12 months thereafter.
- Either, discharge the battery using the connected customer load. The discharge duration for any load can be found in the discharge table in the data sheet.
- Or, discharge the battery by isolating then connecting to a dedicated load bank. The discharge duration for any load can be found in the discharge table in the data sheet.
- Measure and record the voltage of the individual blocks to detect faulty blocks and aging symptoms in order to consider battery replacement in good time.
- Discharge must not be continued below the final discharge voltage.
- The voltage of the single cells or battery blocks shall be recorded automatically or measured by hand. In the latter case, the values shall be recorded at least after 25%, 50% and 80% of the expected discharge time then at regular intervals to ensure the final discharge voltage is captured.
- The test shall be ended if one of the following criteria is fulfilled, whichever comes first:
  - Either, the complete battery string voltage has reached the final discharge voltage per cell multiplied by the number of cells in the string(s).
  - Or, the weakest battery block has fallen below the final discharge voltage per cell (V/cell cut-off x 6 cells) less 0,49 V.

- E.g. U/min= 1,75 V/Cell => (6x1,75)-0,49 V = 10,01 V.
- Use the log tables provided to record the results for future reference.
- After each discharge immediately return the battery system to charge (see chapter 5 'Operation').
- For more in depth information relating to discharging the battery please contact your local Wing representative.

6.5 Measurement of internal Resistance / Impedance Ri (optional)

- Battery testers which measure the internal resistance can be used to monitor and trend data. Internal resistance measurements do not replace discharge capacity tests as described above (para. 6.4) in determining the truth state of health of the battery. If the Ri measurements are used it is necessary to have reference values.
- Between 2 and 7 days on float charge the first battery block readings should be measured and recorded.
- Read and record the Ri every 12 months.
- Interpretation of values:
  - If Ri is 35% higher compared to initial value perform an equalization charge (see chapter 2.2 'Equalization Charge').
  - The measurement must be repeated.
    - If the Ri is no longer 35% higher compared to initial value: No further action required.
    - If the Ri is still >35%higher: Capacity test should be carried out (see chapter 6.4 'Periodic Discharging').
- All measurements can be compared only if the temperature does not differ more than +/- 2˚C.
- For lower Ri no activity is necessary.
- Please note: Due to the sensitive nature of internal impedance measurements it is recommended that the same model of measuring device is used throughout the entirety of the service life of the battery.
- Also, see diagram below, actual positioning of the measuring probes in relation to the battery terminals should be consistent and in line with the instruction shown to ensure the readings are accurate and not subject to any anomalous measurement due to poor probe connections.



Stationary Battery Log Sheet

Note: Duplicate this page, adding the appropriate string and Cell / Monoblock numbers as and when required

String N°: ..... On Load / Off Load / On Charge *

Time Interval:

C/M	V	Ri	C/M	V	Ri	C/M	V	Ri	C/M	V	Ri
1			31			61			91		
2			32			62			92		
3			33			63			93		
4			34			64			94		
5			35			65			95		
6			36			66			96		
7			37			67			97		
8			38			68			98		
9			39			69			99		
10			40			70			100		
11			41			71			101		
12			42			72			102		
13			43			73			103		
14			44			74			104		
15			45			75			105		
16			46			76			106		
17			47			77			107		
18			48			78			108		
19			49			79			109		
20			50			80			110		
21			51			81			111		
22			52			82			112		
23			53			83			113		
24			54			84			114		
25			55			85			115		
26			56			86			116		
27			57			87			117		
28			58			88			118		
29			59			89			119		
30			60			90			120		

Key: C/M = Cell or Monobloc

* Delete as required

Stationary Battery Log Sheet

Customer Reference:	
Inspected / Tested by:	Date:
Battery Type:	Configuration:
Original Installation Date:	Next service Date:

Commisioning / Routine Service Date: *	System Load:	
Float Test: YES/NO *	Float Current:	Total Float Voltage:

Load Details:		
Load Test YES/NO *	Load Duration:	Interval:

Observations:

Notes: This document should be kept for record purpose

* Delete as required