Data Sheet

Rechargeable batteries

A comprehensive range of rechargeable cells and batteries is available. Each chemical couple used is suited to a particular application, the following table details the performance of all battery types. In addition, a short description is given below on each type indicating their prime uses and charging methods.
The capacity of a cell or battery is measured in ampere hours (Ah). If a cell or battery is discharged under constant current (or constant load resistance) conditions until a specified end point voltage is reached, the capacity is quoted as the product of steady current and discharge time. Because capacity is dependent on load, either the load resistance, the load current, or the discharge time should be specified. The capacity measured for a 5 hour discharge is quoted as C5, for a 20 hour discharge C20, etc. The discharge current at the 20 hour rate is similarly referred to as I_{20}.

Lead-acid

Sealed lead-acid batteries differ from standard wet lead-acid batteries in that they need no topping up with de-ionised water. Any hydrogen and oxygen generated internally can be recombined so during normal charging there is no water loss. **RS** dryfits are made with an acid gel, and therefore contain no liquid. **RS** high capacity, **RS** Cyclon, and standard standby Yuasa batteries use a liquid acid in a retentive separator.
There are two main applications, therefore two major types of lead-acid battery, cyclic and standby (float). **Cyclic** batteries can be heavily charged and discharged repeatedly. **Standby** are typically used for battery back-up. These batteries are constantly trickle charged until they are needed, they can then deliver high currents typically required in the event of a failure of the main power source.
Lead-acid RS dryfit A500 suitable for: Regular cyclic use or standby float applications; equipment requiring high discharge currents; unattended equipment requiring batteries with low self discharge currents; stationary or mobile installations.
Lead-acid **RS** dryfit A300 suitable for: Standby/float applications in alarm control panels and other security related products; standby power for unattended equipment.
Lead-acid **RS** Cyclon: Applications as dryfit.
Lead-acid Endurance range: High capacity standby batteries for UPS and other battery backup applications. Commonly connected together to form larger batteries in large installations.
Lead-acid **RS** standard standby (NP range): Commonly used in security systems these are standby or cyclic batteries.
Lead-acid RS standby (NPL range): The same size and performance as standard NP batteries but with an extended standby life of 7-10 years for UPS applications.
Lead-acid cyclic (NPC Range): An extension to the NP. family of batteries. The NPC range have a modified internal construction to provide NP type performance in cyclic applications.

Nickel cadmium cells

These rechargeable batteries are typically used in tools, T & M and domestic equipment. NiCd batteries can be recharged hundreds of times using a constant current charger. They have an extremely long shelf life of up to five years in any state of charge. They can prove to be cost effective compared to non-rechargeable although initial purchase price of the battery and charger, of course, is higher.
Suitable for cyclic and standby applications where extreme ruggedness and/or high peak currents are required. In addition these cells offer very long service life and can withstand a degree of electrical misuse without damage. Some NiCd cells can accept a fast charge (1 hour), which is often a requirement for the back-up systems of portable telecommunications equipment.
Sintered cells have fairly high self discharge currents and are therefore not suitable for equipment which has to be operational without recharging, after being left unattended for long periods of time.
Mass plate cells: Applications where small size and ruggedness are required. These cells have low self discharge currents and are ideal in many small portable equipments. These are available in a range of sizes, several PCB mounting types and several forms specifically for use in cordless telephones.
Battery packs, comprising high capacity, low internal resistance, pressed plate NiCd cells can be used in either cyclic or float applications requiring a back-up system, or in applications requiring high peak currents.
NiCd high temperature sintered cells: Primarily for use in emergency lighting installations these cells and batteries are particularly suitable for charging and discharging at elevated temperatures. Other applications include alarm control panels, emergency and other standby areas where higher ambient temperatures are experienced.

Nickel metal hydride

Nickel metal hydride technology offers similar performance characteristics to Nickel Cadmium. The PCB batteries included in the **RS** Catalogue can, in most applications, be used as a direct replacement. Many widely available cell sizes will not act as a direct replacement for Nickel Cadmium because maximum output current and charge currents will differ.

Vanadium pentoxide lithium

Vanadium lithium cells offer high capacities with low self discharge rates. The low output current makes them ideal for memory backup applications.

Table 1 **Battery ratings and storage**

Battery type and **RS** stock no.			Ratings-On-load Voltage Fully charged	Discharged	Capacity	Shelf life (see note 1)	Storage temp.
Lead-acid endurance range					(10hrs discharge rate)		
200-1392	6V, 80Ah		N/A	N/A	80Ah		
200-1409	6V, 100Ah		N/A	N/A	100Ah	6 months	
200-1415	6V, 160Ah		N/A	N/A	160Ah	to 80%	20°C
200-1421	6V, 320Ah		N/A	N/A	320Ah	of capacity	
200-1443	6V, 480Ah		N/A	N/A	480Ah		
Lead-acid Yuasa NP					(20hrs discharge rate)		
597-784	6V, 1.2Ah	NP1.2-6	6.20-6.35V	5.25V	1.1Ah		
814-821	6V, 2.8Ah	NP 2.8-6	6.20-6.35V	5.25V	2.6Ah		
815-329	6V, 4Ah	NP 4-6	6.20-6.35V	5.25V	4Ah		
597-790	6V, 10Ah	NP10-6	6.20-6.35V	5.25V			
597-807	12V, 1.2Ah	NP1.2-12	12.40-12.70V	10.50V	1.11Ah		
597-813	12V, 2.1Ah	NP2.1-12	12.40-12.70V	10.50V	1.76Ah		
597-829	12V, 2.8Ah	NP2.8-1.2	12.40-12.70V	10.50V	2.41Ah		
198-8052	12V, 3.2Ah	NP3.2-12	12.40-12.70V	10.50V	3.2Ah		
198-8068	12V, 4Ah	NP4-12	12.40-12.70V	10.50V	4Ah	24 months	10-15 years
597-835	12V, 7Ah	NP7-12	12.40-12.70V	10.50V	6.48Ah	to 80%	0°C to+50° when
597-841	12V, 12Ah	NP12-12	12.40-12.70V	10.50V	11.10Ah	capacity	fully charged
200-6505	12V, 17Ah	NP17-12	12.40-12.70V	10.50V	17Ah		
597-857	12V, 24Ah	NP24-12	12.40-12.70V	10.50V	22.20Ah		
198-8074	12V, 24Ah	NPL24-12	12.40-12.70V	10.50V	22.20Ah		
597-863	12V, 38Ah	NP38-12	12.40-12.70V	10.50V	35.15Ah		
198-8153	12V, 38Ah	NPL38-12	12.40-12.70V	10.50V	35.15Ah		
128-7393	12V, 65Ah	NP65-12	12.40-12.70V	10.50V	60.12Ah		
198-8169	12V, 65Ah	NPL65-12	12.40-12.70V	10-50V	60.12Ah		
198-8119	12V, 17Ah	NPC17-12	12.40-12.70V	10-50V	17Ah		
198-8125	12V, 24Ah	NPC24-12	12.40-12.70V	10-50V	24Ah		
Lead-acid RS Dryfits A500					(20hrs discharge rate)		
597-239	2V, 10Ah		2.10-2.15V	1.75V	10Ah		
919-768	4V, 3.5Ah		4.2-4.3V	3.5V	3.5Ah		
919-774	6V, 1.2Ah		6.20-6.35V	5.25V	1.2Ah		
919-780	6V, 3.5Ah		6.30-6.45V	5.25V	3.5Ah		
597-245	6V, 6.5Ah		6.30-6.45V	5.25V	6.5Ah		
597-251	6V,10Ah		6.30-6.45V	5.25V	10Ah		
919-796	8V,3.5Ah		8.40-8.60V	7.00V	3.5Ah		Fully charge
180-358	12V, 1.2Ah		12.40-12.70V	10.50V	1.2Ah		-50°C +70°C
595-047	12V, 2Ah		12.60-12.90V	10.50V	2Ah		half charged
595-053	12V, 3.5Ah		12.60-12.90V	10.50V	3.5Ah	24 months	-10°C +70°C
595-069	12V, 6.5Ah		12.60-12.90V	10.50V	6.5Ah	@T_a=20°C	discharged
595-075	12V, 10Ah		12.60-12.90V	10.50V	10Ah		-5°C +70°C
595-081	12V, 16Ah		12.60-12.90V	10.50V	16Ah		
595-097	12V, 25Ah		12.60-12.90V	10.50V	25Ah		
595-104	12V, 30Ah		12.60-12.90V	10.50V	30Ah		
595-110	12V, 40Ah		12.60-12.90V	10.50V	40Ah		
919-803	12V, 65Ah		12.60-12.90V	10.50V	65Ah		
595-126	12V, 85Ah		12.60-12.90V	10.50V	85Ah		
595-132	12V, 115Ah		12.60-12.90V	10.50V	115Ah		
Lead-acid RS Dryfits A300					(10hrs discharge rate)		
593-029	6V, 1.0Ah		6.30-6.45V	5.25V	1.0Ah		
593-013	6V, 1.1Ah		6.30-6.45V	5.25V	1.1Ah		Fully charged
593-007	6V, 3.0Ah		6.30-6.45V	5.25V	3.0Ah		-50°C +70°C
592-149	6V, 9.5Ah		6.30-6.45V	5.25V	9.5Ah	16 months	half charged
591-922	12V, 1.1Ah		12.60-12.90V	10.50V	1.1Ah	@T_a=20°C	-10°C +70°C
591-966	12V, 1.8Ah		12.60-12.90V	10.50V	1.9Ah		discharged
591-938	12V, 3.0Ah		12.60-12.90V	10.50V	3.0Ah		-5°C +70°C
591-944	12V, 5.7Ah		12.60-12.90V	10.50V	5.7Ah		
593-035	12V, 9.5Ah		12.60-12.90V	10.50V	9.5Ah		
Lead-acid RS Cyclons					(10hrs discharge rate)		
591-461	2V, 2.5Ah				2.5Ah	150 days	
591-483	2V, 5.0Ah		2.15-2.18V	1.6V	5.0Ah	T_a=20°C	-65°C +65°C
322-120	2V, 12.5Ah				12.5Ah		
591-629	2V, 25Ah				25.0Ah		
Lead-acid 996						Fully charge -	
200-1207	996		6.4V	5.25V	4.5Ah	24 months	50°C +70°C
						@T_a=20°C	half charged-10°C +70°C
							discharged -5°C +70°C
NiCd Sintered Cells					(5hrs discharge rate)		
592-026		N	1.24-1.27V	1.0V	150m Ah		
591-146		AAA	1.24-1.27V	1.0V	220m Ah		
816-798		1/3AA	1.24-1.27V	1.0V	110m Ah		
229-093		1/2AA	1.24-1.27V	1.0V	300m Ah	120 days	
228-034		1/2A	1.24-1.27V	1.0V	450m Ah	T_a=0°C	-40°C +60°C
212-2304		4/5A	1.24-1.27V	1.0V	1.9Ah		
228-012 (tagged)		AA	1.24-1.27V	1.0V	600m Ah	40 days	possible
185-5536 (untagged)		AA	1.24-1.27V	1.0V	600m Ah	T_a=20°C	0°C +30°C
196-6709		4/5A	1.24-1.27V	1.0V	1.2Ah		
592-363		RR	1.24-1.27V	1.0V	1.4Ah	11 days	
228-028 (tagged)		C	1.24-1.27V	1.0V	2.2Ah	T_a=40°	
215-1324 (untagged)		C	1.24-1.27V	1.0V	2.2Ah		
229-116		1/2D	1.24-1.27V	1.0V	2.4Ah		
229-065 (tagged)		D	1.24-1.27V	1.0V	4Ah		
212-2326 (untagged)		D	1.24-1.27V	1.0V	4Ah		
229-122		F	1.24-1.27V	1.0V	7Ah		
229-138		Super F	1.24-1.27V	1.0V	10Ah		
229-059		PP9	8.68-8.90V	7.0V	1.2Ah		
High Capacity NiCd Sintered Cells					T_a=0°C	120 days -40°C +60°C	
598-664		AA	1.22-1.27V	1.0V	800m Ah	40 days	possible
594-662		RR	1.22-1.27V	1.0V	1.7Ah	T_a=20°C	+5°C +25°C
849-473		2/3 Af	1.22-1.27V	1.0V	1.2Ah	11 days	recommended
594-684		Af	1.22-1.27V	1.0V	600m Ah	T_a=40°C	
High Capacity NiCd (without tags)						120 days T_a=0°C 40 days T_a=20°C 11 days	-40°C +60°C possible +5°C +25°C
598-692		AA	1.22-1.27V	1.0V	800m Ah		
NiCd Camcorder						120 days T_a=0°C 40 days T_a=20°C 11 days T_a=40°C	
919-819			6.0V	-	2.4Ah		-20°C +35°C possible

Table 1 **Battery ratings and storage (continued)**

Battery type and **RS** stock no.		Ratings-On-load Voltage Fully charged	Discharged	Capacity	Shelf life (see note 1)	Storage temp.
Battery Packs (NiCd)						
321-509	10 × AA	12.4-12.7V	10V	650m Ah	120 days	
321-515	10 × C	12.4-12.7V	10V	2.5Ah	T_a=0°C	
321-521	10 × D	12.4-12.7V	10V	4.3Ah	40 days	-40°C +50°C
596-107	20 × AA	24.8-25.4V	20V	650m Ah	T_a=20°C	possible
596-129	5 × AA	6.2-6.4V	6V	650m Ah	11 days	
596-113	6 × AA	8.7-8.9V	7V	650m Ah	T_a=40°C	
596-135	20 × RR	24.8-25.4V	20V	1.7Ah		
NiCd High Temp Cells				(5hrs discharge rate)		
595-019	D	1.24-1.27V	1.00V	4Ah		-40°C to +60°C
598-670	2 × D, Stick	2.48-2.54V	2.00V	4Ah	55 days	possible
595-025	3 × D, Stick	3.73-3.88V	3.00V	4Ah	T_a=20°C	+5°C to +25°C
595-031	3 × D, Plate	3.72-3.88V	3.00V	4Ah		
596-630	4 × D, Stick	4.96-5.08V	4.00V	4Ah		
814-815	5 × D, Stick	6.20-6.35V	5.00V	4Ah		
NiCd Mass Plate				(10hrs discharge rate)		
592-278	2 Cell PCB Battery	2.48-2.54V	2.00V	110m Ah		
591-477	3 Cell PCB Battery	3.72-3.81V	3.00V	110m Ah		
233-317	4 Cell PCB Battery	4.96-5.08V	4.00V	110m Ah		
592-284	5 Cell PCB Battery	6.2-6.35V	5.00V	280m Ah	26 months	
595-441	PCB Battery	2.4V	2.0V	40m Ah	T_a=0°C	
595-435	PCB Battery	3.6V	3.0V	40m Ah	10 months	
591-089	PP3	8.68-8.89V	7.00V	110m Ah	T_a=20°C	-40°C +50°C
591-168	Button Cell	1.24-1.27V	1.00V	170m Ah	1 month	0°C +45°C
593-518	Button Cell	1.24-1.27V	1.00V	280m Ah	Ta=40°C	recommended
593-552	Button Cell	3.6V	3.00V	10m Ah		
591-180	7 Cell Stack	8.68-8.89V	7.00V	170m Ah		
593-524	5 Cell Stack	6.2-6.35V	5.00V	280m Ah		
595-457	Cordless telephone batteries	2.4V	2.0V	280m Ah		
595-463		3.6V	3.0V	280m Ah		
595-479		3.6V	3.0V	260m Ah		
595-485		2.4V	2.0V	700m Ah		
595-491		3.6V	3.0V	700m Ah		
157-8481		3.6V	3.0V	400m Ah		
157-8469		3.6V	3.0V	700m Ah		
157-8497		4.8V	4.0V	280m Ah		
NMH PCB batteries						
422-371	2 Cell PCB Battery	2.4V	2.0V	110m Ah	Less than	-40 to +65°C
422-387	3 Cell PCB Battery	3.6V	3.0V	11m Ah	20% self-	
422-393	3 Cell PCB Battery	3.6V	3.0V	110m Ah	discharge	
422-400	4 Cell PCB Battery	4.8V	4.0V	110m Ah	after 1	
422-416	5 Cell PCB Battery	6.0V	5.0V	280m Ah	month @ 20°C	
213-0743	Flat cell	1.2	1.0	600mAh		
213-0759	3 x Flat cell	3.6	3.0	600mAh	>5 years at	0.45°C
213-0771	5 x Flat cell	6.0	5.0	600mAh	20°C	
NMH						
184-9317	9V PP3	9.0V	7.0V	110m Ah	Less than 20%	-40 to 35°C
212-2332	AA	1.2V	1.0V	1.1Ah	self-discharge	
215-1318	4/5A	1.2V	1.0V	1.6mAh	after 1 month	
				@ 20°C		
Vanadium Lithium						
407-861	1220	3V	2.5V	7m Ah	Annual self-	
407-877	2020	3V	2.5V	20m Ah	discharge	—
407-883	2320	3V	2.5V	30m Ah	rate of 2%	
407-899	2330	3V	2.5V	50m Ah		
407-906	3032	3V	2.5V	100m Ah		

Notes:
1. Period after which capacity has fallen to 60% (Dryfits 50%) of its original fully charged level.
2. Period after which only 60% of the stated capacity is obtainable once charged (where applicable) and stored at the recommended temperature.
3. Recharge every 16 months.
4. Recharge every 3 years when stored at 20°C.

Table 2 **Battery charge information**

Battery type and **RS** stock no			Charge mode	Charge rate continuous (Float)	Charge rate non-continuous (Cyclic)	Charge rate Max.	Charge Ø (note 1)	Temp. range	1A equipment mounting	1A multi-range	5A equipment mounting	15A bench mounting	2 stage charging 129-662 or 129-678
Lead-acid Endurance range													
High Capacity			Constant										
200-1392	6V 80Ah		voltage	2.25-2.27V per cell	N/A	8A	-		N/A	N/A	N/A	N/A	N/A
200-1409	6V 100Ah		charged	2.25-2.27V per cell	N/A	10A	-		N/A	N/A	N/A	N/A	N/A
200-1415	6V 160Ah		at	2.25-2.27V per cell	N/A	16A	-	-15°C to	N/A	N/A	N/A	N/A	N/A
200-1421	2V 320Ah		2.26V	2.25-2.27V per cell	N/A	32A	-	+50°C	N/A	N/A	N/A	N/A	N/A
200-1443	2V 480Ah		per cell	2.25-2.27V per cell	N/A	48A	-		N/A	N/A	N/A	N/A	N/A
Lead-acid Yuasa NP													
597-784	6V 1.2Ah	NP1.2-6		6.75-6.9V	7.2-7.5V	7.5V	-	-	129-713	129-684	N/A	815-256	N/A
814-821	6V 2.8Ah	NP2.8-6		6.75-6.9V	7.2-7.5V	7.5V	-	-	129-713	129-684	N/A	815-256	N/A
815-329	6V 4Ah	NP4-6		6.75-6.9V	7.2-7.5V	7.5V	-	-	129-713	129-684	N/A	815-256	N/A
597-790	6V 10Ah	NP10-6		6.75-6.9V	7.2-7.5V	7.5V	-	-	-	-	N/A	815-256	N/A
597-807	12V 1.2Ah	NP1.2-12	Constant	13.50-13.8V	14.4-15.0V	15.0V	-	-	129-707	129-684	N/A	815-256	N/A
597-814	12V 2.1Ah	NP2.1-12	voltage	13.50-13.8V	14.4-15.0V	15.0V	-	-	129-707	129-684	N/A	815-256	N/A
597-829	12V 2.8Ah	NP2.8-12	initial	13.50-13.8V	14.4-15.0V	15.0V	-	-	129-707	129-684	N/A	815-256	N/A
198-8052	12V 3.2Ah	NP3.2-12	coolant	13.50-13.8V	14.4-15.0V	15.0V	-	-	129-707	129-684	N/A	815-256	N/A
198-8068	12V 4Ah	NP4-12	limited	13.50-13.8V	14.4-15.0V	15.0V	-	-	129-707	129-684	N/A	815-256	N/A
597-835	12V 7Ah	NP7-12	to 0.02°C	13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	N/A
597-841	12V 12Ah	NP12-12		13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	N/A
200-6505	12V 17Ah	NP17-12		13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	N/A
597-857	12V 24Ah	NP24-12		13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	Yes
198-8074	12V 24Ah	NPL24-12		13.50-13.8V	14.4-15.0V	15.0V			-	-	N/A	815-256	Yes
597-863	12V 38Ah	NP38-12		13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	Yes
198-8153	12V 38Ah	NPL38-12		13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	N/A
128-7393	12V 65Ah	NP65-12		13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	Yes
198-8169	12V 65Ah	NPL65-12		13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	N/A
198-8119	12V 17Ah	NPC17-12		13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	N/A
198-8125	12V 24Ah	NPC24-12		13.50-13.8V	14.4-15.0V	15.0V	-	-	-	-	N/A	815-256	N/A

Table 2 Battery charge information (continued)

Battery type and RS stock no.	Charge rate Charge mode	Charge rate continuous (Float)	Charge non-continuous (Cyclic)	rate Max.	Charge Ø (note 1)	Temp. range	1A equipment mounting	1A multi-range	5A equipment mounting	15A bench mounting	2 stage charging 129-662 or 129-678
Lead-acid RS Dryfits A500				(see text)							
597-239 2V, 10Ah		2.3-2.35V	2.40-2.45V	2.4V	-		-	-	N/A	N/A	N/A
919-768 4V, 3.5Ah		4.6-4.7V	4.8-4.9V	4.8V	-		-	-	N/A	N/A	N/A
919-774 6V, 1.2Ah		6.9-7.05V	7.2-7.35V	7.35V	-		129-713	129-684	N/A	N/A	N/A
919-780 6V, 3.5Ah		6.9-7.05V	7.20-7.35V	7.2V	-		129-713	129-684	N/A	N/A	N/A
597-245 6V, 6.5Ah		6.9-7.05V	7.20-7.35V	7.2V	-		129-713	129-684	593-394	N/A	N/A
597-251 6V, 10Ah		6.9-7.05V	7.20-7.35V	7.2V	-		-	-	593-394	N/A	N/A
919-796 8V, 3.5Ah	Parallel	9.2-9.4V	9.6-9.8V	9.8V	-	-30°C	N/A	129-684	593-394	N/A	N/A
180-358 12V, 1.2Ah	constant	13.8-14.1V	14.4-14.7V	14.4V	-	to	129-707	129-684	593-394	N/A	N/A
595-047 12V, 2Ah	voltage	13.8-14.1V	14.4-14.7V	14.4V	-	+50°C	129-707	129-684	593-394	N/A	N/A
595-053 12V, 3.5Ah		13.8-14.1V	14.4-14.7V	14.4V	-		129-707	129-684	593-394	N/A	N/A
595-069 12V, 6.5Ah		13.8-14.1V	14.4-14.7V	14.4V	-		129-707	129-684	593-394	N/A	N/A
595-075 12V, 10Ah		13.8-14.1V	14.4-14.7V	14.4V	-		-	-	593-394	N/A	Yes
595-081 12V, 16Ah		13.8-14.1V	14.4-14.7V	14.4V	-		-	-	593-394	N/A	Yes
595-097 12V, 25Ah		13.8-14.1V	14.4-14.7V	14.4V	-		-	-	593-394	N/A	Yes
595-104 12V, 30Ah		13.8-14.1V	14.4-14.7V	14.4V	-		-	-	593-394	N/A	Yes
595-110 12V, 40Ah		13.8-14.1V	14.4-14.7V	14.4V	-		-	-	593-394	N/A	Yes
919-803 12V, 65Ah		13.8-14.1V	14.4-14.7V	14.4V	-		-	-	593-394	N/A	Yes
595-126 12V, 85Ah		13.8-14.1V	14.4-14.7V	14.4V	-		-	-	593-394	N/A	Yes
595-132 12V, 115Ah		13.8-14.1V	14.4-14.7V	14.4V	-		-	-	593-394	N/A	Yes
Lead-acid RS Dryfits A300				(see text)							
593-029 6V, 1.0Ah		6.90V	7.05V	7.05V			129-713	129-684	593-394	N/A	No
593-013 6V, 1.1Ah		6.90V	7.05V	7.05V			129-713	129-684	593-394	N/A	No
593-007 6V, 3.0Ah		6.90V	7.05V	7.05V			129-713	129-684	593-394	N/A	No
592-149 6V, 9.5Ah	Parallel	6.90V	7.05V	7.05V		-30°C	129-713	129-684	593-394	N/A	No
591-922 12V, 1.1Ah	constant	13.80V	14.10V	14.10V	90%	to	129-707	129-684	593-394	591-893	No
591-966 12V, 1.8Ah	voltage	13.80V	14.10V	14.10V		+50°C	129-707	129-684	593-394	591-893	No
591-938 12V, 3.0Ah		13.80V	14.10V	14.10V			129-707	129-684	593-394	591-893	No
591-944 12V, 5.7Ah		13.80V	14.10V	14.10V			129-707	129-684	593-394	591-893	No
593-035 12V, 9.5Ah		13.80V	14.10V	14.10V			-	-	593-394	591-893	No
Lead-acid RS Cyclons	Constant	(see text)	(see text)	(see text)					(see note 3)		
591-461 2V, 2.5Ah	voltage (or	2.30-2.40V	2.40-2.55V	2.55V		-40°C	N/A	N/A	593-394	N/A	N/A
591-483 2V, 5.0Ah	constant	2.30-2.40V	2.40-2.55V	2.55V	~95%	to	N/A	N/A	593-394	N/A	N/A
322-120 2V, 12.5Ah	current)	2.30-2.40V	2.40-2.55V	2.55V		+65°C	N/A	N/A	593-394	N/A	N/A
591-629 2V, 25Ah		2.30-2.40V	2.40-2.55V	2.55V			N/A	N/A	593-394	N/A	N/A
Lead-acid 996	Constant										
200-1207 996	voltage	6.9V	7.15V	7.15V	-	+5°C+40°C		129-684	-	-	-

Battery type and **RS** stock no.	Charge mode	Charge rate continuous (Float)	Charge rate non-continuous (Cyclic)	Charge rate Max	Charge Ø (note 1)	Temp range	Suitable **RS** charger **RS** stock no.
Ni Cd Sintered Cells			(see text)			+10°C+65°C	
592-026 N		8mA	15mA	C/4		unrestricted	
591-146 AAA		11mA	22mA	C/4		-20°C0°C	
						with voltage	
						limit of 1.55V	
816-798 1/3AA		5mA	10mA	-			
229-093 1/2AA		12mA	24mA	-		+10°C+65°C	A wide range of suitable
228-034 1/2A		23mA	45mA	-		normal charge	**RS** chargers are available.
212-2304 4/3A		190mA	1.9A	1C		+5 to 50°C	
228-012 (tagged) AA	Series	30mA	60mA	-		+10°C+45°C	Please refer to current
185-5536(untagged) AA	Series	30mA	60mA	-	60% @	unrestricted	**RS** Catalogue.
196-6709 4/5A		60mA	120mA				
592-363 1/2 RR	constant	70mA	140mA	-	C/10	-20°C 0°C	
228-028 (tagged)	C	current	110mA	220mA	10C	80% @	with voltage
215-1324 (untagged) C		220mA	2.2mA	1C		+5 to 50°C	
229-116 D		120mA	240mA	-	C/2	limit of 1.55V	
229-065 (tagged)	D		200mA	400mA	-	90% @	
212-2326 (untagged) D		400mA	4A	1C		+5 to 50°C	
229-122 F		350mA	700mA	-	C		
229-138 Super F		500mA	1000mA				
229-059 PP9		60mA	120mA	2C			
High Capacity Ni Cd Sintered Cells				(see text)		0°C +50°C	
594-656 AA	Series	40mA	80mA	10C	60% @	normal	
594-662 RR	constant	85mA	170mA	10C	C/10	16h charge	See text
849-473 2/3Af	current	60mA	120mA	10C	90% @	+10°C to	
594-684 Af		30mA	60mA	10C	C	+50°C	
						with voltage	
						limit of 1.55V	
High Capacity Ni Cd (without tags)			80mA	(see text)		0°C +50°C	
598-692 AA	Series	40mA	for 16hrs		60% @	normal	
	constant		800mA		C/10	16th charge	See text
	current		for 1.2 hrs		90% @	+10°C to	
					C	+50°C	
						with voltage	
						limit of 1.55V	
Ni Cd camcorder 919-819	**Purpose-built charger supplied with most camcorders**						

Table 2 Battery charge information (continued)

Battery type and **RS** stock no.	Charge mode	Charge rate continuous (Float)	Charge rate non-continuous (Cyclic)	Charge rate Max.	Charge Ø (note 1)	Temp. range	Suitable **RS** charger **RS** stock no.
Battery Packs (NiCd)				(see text)			
321-509 10 × AA		60mA	150mA	C/4			
321-515 10 × C		230mA	230mA	C/10	60% @		
321-521 10 × D	Series	400mA	400mA	C/10	C/10	+15°C to	
596-107 20 × AA	constant	60mA	150mA	C/4	90% @	+50°C	See text
596-129 5 × AA	current	60mA	150mA	C/4	C		
596-113 6 × AA		60mA	150mA	C/4			
596-135 20 × RR		170mA	350mA	C/4			
NiCd High Temp. Cells							
595-019 D		200mA	400mA			400mA	
598-670 2 × D, Stick	Series	200mA	400mA			+10°C +65°C	
595-048 3 × D, Stick	constant	200mA	400mA	2C	84%	(cyclic)	129-690
595-031 3 × D, Plate	current	200mA	400mA			200mA	
596-630 4 × D, Stick		200mA	400mA			+15°C +45°C	
814-815 5 × D, Stick		200mA	400mA			(continuous)	
NiCd Mass Plate							
592-278 2 Cell PCB Battery		1.1mA	11mA				-
591-477 3Cell PCB Battery		1.1mA	11mA				-
233-317 4Cell PCB Battery		1.1mA	11mA				-
592-284 5Cell PCB Battery		2.8mA	28mA				-
595-441 PCB Battery		0.4mA	4mA				-
595-435 PCB Battery		0.4mA	4mA			Max limits	-
591-089 PP3		1.1mA	11mA			0°C +45°C	-
591-168 Button Cell	Series	1.7mA	17mA			+10°C +35°C	-
593-518 Button Cell	constant	2.8mA	28mA			recommended	-
593-552 Button Cell	current	0.1mA	1mA	C/10	72%	591-441 +	-
591-180 7 Cell Stack		1.7mA	17mA			591-435	-
593-524 5 Cell Stack		2.8mA	28mA			upper limit	-
595-457		2.8mA	28mA			+65°C	-
595-463		2.8mA	28mA				-
595-479 Cordless		2.6mA	26mA				-
595-485 telephone		7.0mA	70mA				-
595-491 batteries		7.0mA	70mA				-
157-8481		4.0mA	40mA				-
157-8469		7.0mA	70mA				-
157-8497		2.8mA	28mA				-
NMH PCB Batteries							
422-371 2 Cell PCB Battery		1.1mA	11mA				
422-387 3 Cell PCB Battery		0.11mA	1.1mA				
422-393 3 Cell PCB Battery		1.1mA	11mA	C/10	-	0 to 65°C	See text
422-400 4 Cell PCB Battery		1.1mA	11mA				
422-416 5 Cell PCB Battery		2.8mA	28mA				
213-0743 Flat cell		60mA	600mA			0 to 45°C	
213-0759 3 x Flat cell		60mA	600mA	1.0C		at C/10	-
213-0771 5 x Flat cell		60mA	600mA			10 to 40°C	
						at 1.0 x C	
NMH PP3							
184-9317 9V PP3		3.3mA	11mA	C/5	-	+10 to 35°C	595-536
212-2332 AA		110mA	1100mA	(7 hours)		+10 to 40°C	-
215-1318 AA		160mA	1600mA			+10 to 40°C	-
Vanadium Lithium							
407-861 VL 1220			0.5mA				
407-877 VL 2020	Series		1.5mA				
407-883 VL 2320	constant	N/A	2.0mA	N/A	N/A	-20 to +60°C	See text
407-899 VL 2330	voltage		2.0mA				
407-906 VL 3032			4.0mA				

Notes:

1. Ø = energy stored in the battery / energy supplied to the battery
2. At temperatures below 0°C charge unit is limited to 120mA and voltage to a maximum of 1.55V/cell.
3. Charger **RS** stock no. 593-394 is suitable for 6V or 12V Cyclon battery stacks.

Table 3 **Battery discharge information**

Battery type and **RS** stock no			Discharge temp.	I Max. (see note 1)	Cyclic life	Standby life	R_{int} (dc)	R_{int} (ac) 50Hz
Lead-acid endurance range								
200-1392	6V 80Ah			800A			1.8mΩ	
200-1409	6V 100Ah			1000A			1.8mΩ	
200-1415	6V 160Ah		-20°C to +60°C	1500A	-	10 years	1.2mΩ	-
200-1421	6V 320Ah			3000A			0.3mΩ	
200-1443	6V 480Ah			4500A			0.2mΩ	
Lead-acid Yuasa NP						to 30% depth of discharge		
597-784	6V 1.2Ah	NP 1.2-6		10A	1200	3-5 years	60mΩ	-
814-821	6V 2.8Ah	NP 2.8-6		40A	1200	3-5 years	35mΩ	-
815-329	6V 4Ah	NP 4-6		40A	1200	3-5 years	35mΩ	-
597-790	6V 10Ah	NP 10-6		40A	1200	3-5 years	10mΩ	-
597-807	12V 1.2Ah	NP 1.2-12		40A	1200	3-5 years	120mΩ	-
597-813	12V 2.1Ah	NP 2.1-12		40A	1200	3-5 years	54mΩ	-
597-829	12V 2.8Ah	NP 2.8-12	-5°C to +50°C	40A	1200	3-5 years	58mΩ	-
198-8052	12V 3.2Ah	NP 3.2-12		40A	1200	3-5 years	-	-
198-8068	12V 4Ah	NP 4-12		40A	1200	3-5 years	-	-
595-835	12V 7Ah	NP 7-12		40A	1200	3-5 years	30mΩ	-
597-841	12V 12Ah	NP 12-12		40A	1200	3-5 years	16mΩ	-
200-6505	12V 17Ah	NP 17-12		40A	1200	3-5 years	-	-
597-857	12V 24Ah	NP 24-12		150A	1200	3-5 years	10mΩ	-
198-8074	12V 24Ah	NPL 24-12		150	1200	7-10 years	8mΩ	-
597-863	12V 38Ah	NP 38-12		150A	1200	3-5 years	-	-
198-8153	12V 38Ah	NPL 38-12		200A	1200	7-10 years	7mΩ	-
128-7393	12V 65Ah	NP 65-12		500A	1200	3-5 years	-	-
198-8169	12V 65Ah	NPL 65-12		500A	1200	7-10 years	5 mΩ	-
198-8119	12V 17Ah	NPC 17-12		40A	1200	3-5 years	-	-
198-8125	12V 24Ah	NPC 24-12		150A	1200	3-5 years	-	-
Lead-acid RS Dryfits A500								
597-239	2V 10Ah				80A			- -
919-768	4V 3.5Ah			60A			38.5mΩ	
180-358	6V 1.2Ah			40A			140mΩ	119mΩ
919-780	6V 3.5Ah			60A			50mΩ	-
597-245	6V 6.5Ah			80A			-	-
597-251	6V 10Ah			80A			-	
919-774	8V 3.5Ah			40A	-20,000		67mΩ	59mΩ
919-796	12V 1.2Ah		-30°C to +50°C	60A	cycles	8-10 years	280mΩ	238mΩ
595-047	12V 2Ah			40A	(see note 2)		920mΩ	-
595-053	12V 3.5Ah			60A			640mΩ	-
595-069	12V 6.5Ah			80A			360mΩ	-
595-075	12V 10Ah			80A			25mΩ	-
595-081	12V 16Ah			200A			16mΩ	-
595-097	12V 25Ah			200A			16mΩ	-
595-104	12V 30Ah			400A			-	-
505-110	12V 40Ah			400A			10mΩ	-
919-803	12V 65Ah			440A			7mΩ	-
595-126	12V 85Ah			600A			5.6mΩ	-
595-132	12V 115Ah			770A			-	-
Lead-acid RS Dryfits A300								
593-029	6V 1.0Ah			40A			210mΩ	120mΩ
593-013	6V 1.1Ah			40A			191mΩ	109mΩ
593-007	6V 3.0Ah			60A			75mΩ	40mΩ
592-149	6V 9.5Ah			80A	60-6000		22mΩ	4.2mΩ
591-922	12V 1.1Ah		-30°C +50°C	40A	cycles	8-10 years	380mΩ	218mΩ
591-966	12V 1.8Ah			40A	(see note 2)		233mΩ	133mΩ
591-938	12V 3.0Ah			80A			140mΩ	80mΩ
591-944	12V 5.7Ah			80A			74mΩ	42mΩ
593-035	12V 9.5Ah			80A			44mΩ	25mΩ
Lead-acid RS Cyclons							-	(see note 3)
591-461	2V 2.5Ah			130A	˜250	8-10 years to	-	10mΩ
591-483	2V 5.0Ah		-40°C +65°C	200A	cycles	80% capacity	-	5mΩ
322-120	2V 12.5Ah			350A	(see note 5)	(see note 4)	-	4mΩ
591-629	2V 25Ah			750A				2.2mΩ
Lead acid 996								
200-1207	996		-20°C +45°C	3A	600 cycles to IEC896P2	8-10 years	-	-
Ni Cd Sintered Cells					(see note 8)			
592-026		N		0.9A			105mΩ	-
591-146		1/3AAA		1.0A			80mΩ	-
816-798		1/2AA		110mA			-	-
229-093		1/2AA		4A			40mΩ	-
228-034		1/2A		5A			25mΩ	-
212-2304		4/3A		5.7A				
228-012 (tagged)		AA		5A			28mΩ	-
185-5536 (untagged)		AA		5A	700-1000		28mΩ	-
196-6709		4/5A		3.6A			17mΩ	
592-363		RR	-20°C +50°C	14A	cycles	4-7 years	15mΩ	-
228-028 (tagged)		C		20A			13mΩ	-
215-1324 (untagged)		C		6.6A				
229-116		1/2D		24A			11mΩ	-
229-065 (tagged)		D		35A			5mΩ	-
212-2326 (untagged)		D		20A				
229-122		F		60A			5.5mΩ	-
229-138		SuperF		70A			3mΩ	-
229-059		PP9		2.4A			91mΩ	-
High Capacity Ni Cd Sintered Cells								(see note 3)
594-656		AA		2A			40mΩ	22mΩ
594-662		RR	-40°C	8.5A	700-1000	4-7 years	8mΩ	5mΩ
849-473		Af	+60°C	5.0A	cycles		16mΩ	12mΩ
594-684		2/3Af		3.0A			30mΩ	25mΩ

Table 3 **Battery discharge information (continued)**

Battery type and **RS** stock no.		Discharge temp.	I max. (see note 1)	Cyclic life	Standby life	R_{int} (dc)	R_{int} (ac) 50Hz
High Capacity NiCd (without tags)							(see note 3)
598-692	AA	-20°C +60°C	2A	700-1000 cycles	4-7 years	40Ω	22mΩ
408-987	C	-20 to +65°C	5.4A	700 to 1000 cycles	4-7 years	10mΩ	-
(NiCd) Camcorder							
919-819		-20°C +65°C	2200mA	700 to 1000 cycles	4-7 years	0-1Ω	-
Battery Packs (NiCd)							
321-509	10 × AA		9A			35mΩ	-
321-515	10 × C		29A			19mΩ	-
321-521	10 × D	-20°C	40A	500-1000	4-7 years	11mΩ	-
596-107	20 × AA	+50°C	9A	cycles		35mΩ	-
596-129	5 × AA		9A			35mΩ	-
596-113	6 × AA		9A			35mΩ	-
596-135	20 × RR		15A			22mΩ	-
NiCd High Temp Cells							(see note 3)
595-019	D	(see note 6)				6.5mΩ	3.75mΩ
592-670	2 × D, Stick	-40°C + 65°C				13mΩ	7.5mΩ
595-048	3 × D, Stick	(reduced spec)	20A	500-700	4-7 years	19.5mΩ	11.25mΩ
595-031	3 × D, Plate	-20°C + 45°C		cycles		19.5mΩ	11.25mΩ
596-630	4 × D, Stick	(full spec)				26mΩ	15mΩ
814-815	5 × D, Stick					32.5mΩ	18.75mΩ
NiCd Mass Plate	(see note 7)						
592-278	2 Cell PCB Battery		200mA	500 cycles	5-7 years	1.0Ω	760mΩ
591-477	3 Cell PCB Battery		200mA	500 cycles	5-7 years	1.5Ω	1140mΩ
233-317	4 Cell PCB Battery		200mA	500 cycles	5-7 years	1.5Ω	-
591-284	5 Cell PCB Battery		500mA	500 cycles	5-7 years	1.5Ω	1000mΩ
595-441	PCB Battery	Max. limits	80mA	500 cycles	5-7 years	-	-
595-435	PCB Battery	-20°C + 50°C	80mA	500 cycles	5-7 years	-	-
591-089	PP3	595-441 +	200mA	500 cycles	5-7 years	3.5Ω	2600mΩ
591-168	Button Cell	to + 65°C	340mA	500 cycles	5-7 years	375mΩ	240mΩ
593-518	Button Cell		560mA	500 cycles	5-7 years	200mΩ	80mΩ
593-552	Button Cell	0°C + 45°C	30mA	1000 cycles	4-6 years	10Ω	3Ω
591-180	7 Cell Stack	recommended	340mA	500 cycles	5-7 years	1.87Ω	1680mΩ
593-524	5 Cell Stack		560mA	500 cycles	5-7 years	1.4Ω	400mΩ
595-457			560mA	500 cycles	5-7 years	-	-
595-463	Cordless		560mA	500 cycles	5-7 years	-	-
595-479	telephone		520mA	500 cycles	5-7 years	-	-
595-485	batteries		1400mA	500 cycles	5-7 years	-	-
595-491			1400mA	500 cycles	5-7 years	-	-
NMH PCB Batteries							
422-371	2 Cell PCB Battery		220mA	500cycles	5-7 years	2Ω	-
422-387	3 Cell PCB Battery		22mA	500 cycles	5-7 years	18Ω	-
422-393	3 Cell PCB Battery	-20 to 65°C	220mA	500 cycles	5-7 years	3Ω	-
422-400	4 Cell PCB Battery		220mA	500 cycles	5-7 years	4Ω	-
422-416	5 Cell PCB Battery		560mA	500 cycles	5-7 years	3.5Ω	-
213-0743	Flat cell	0 to 45°C		500 cycles	-	-	-
213-0759	3 x Flat cell	at C/10		500 cycles	-	-	-
213-0771	5 x Flat cell	10 to 40°C at 1.0 x C		500 cycles	-	-	-
NMH							
184-9317	9V PP3	0 to 45°C	200mA	500 cycles	5-7 years	4.9Ω	-
212-2332	AA	0-40°C	3.3A	500 cycles			
215-1318	4/5A	0 to 40°C	4.8A	500 cycles			
Vanadium Lithium							
407-861	VL 1220		20µA			-	-
407-877	VL 2020		70µA	1000 cycles	2% self	-	-
407-883	VL 2320	-20 to 60°C	100µA	10%	discharge	-	-
407-899	VL 2330		100µA	discharge	per annum	-	-
407-906	VL 3032		200µA			-	-

Notes:

1. These continuous currents are only possible if the leads have sufficiently low resistance and are soldered onto the tags where provided.
2. See text.
3. At 1kHz.
4. Kept on float charge of 2.40V/cell at T_a=25°C.
5. At 2.54V charging voltage to 80% capacity.
6. A maximum of 75°C is permissible for up to 24 hours.
7. At temperatures below 0°C, maximum discharge is C/2.
8. Figures are for single cells used in a well ventilated area. For pulse discharges higher currents are permissible.

Lead-acid Batteries

Lead-acid **RS** dryfits A500 and A300.

Note: Unless otherwise specified all details refer to A500 and A300 types.

Dryfit A500 batteries are suitable for both standby/float applications and also for applications where many regular discharge and recharge cycles are required.

Dryfit A300 batteries are designed specifically for use in standby/float applications where an occasional complete discharge/recharge cycle may occur. They are also highly suited for applications with long intervals between individual discharges.

All dryfit batteries are made with a thixotropic gel of acid electrolyte locked between sets of anode and cathode plates housed in a vented high impact ABS case. (Except for sizes above 24Ah which have polypropylene cases.)

Particularly for standby/float applications we recommend coating the battery connections with a silicone grease (**RS** stock no. 494-124), contact grease (**RS** stock no. 566-730) or petroleum jelly.

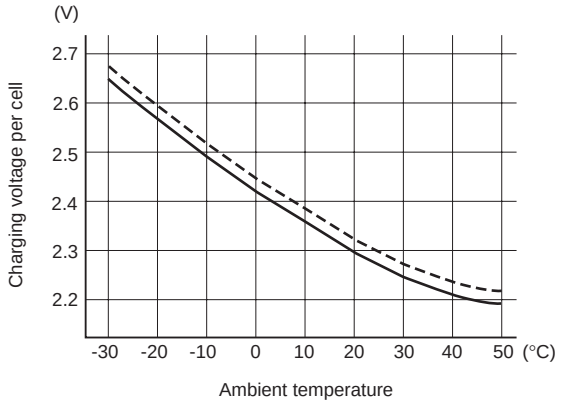
Charging information

These batteries must be charged from a **constant voltage** source. See Table 2 for charging voltages. In the case of continuous operation at higher/lower temperatures, the charging voltage should be adjusted according to the curve in Figure 1.

It should be noted that with constant voltage charging the charge current is regulated automatically by the battery.

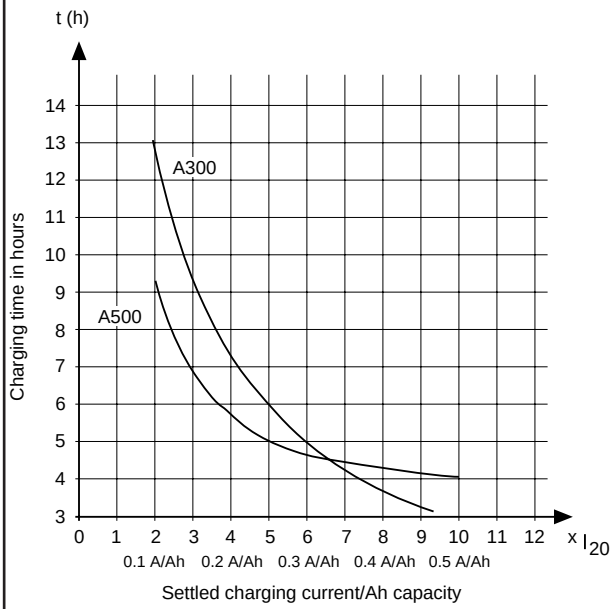
To avoid reaching the temperature-dependent gassing voltage, the charging voltage, including any ripple should not deviate by more than ±30mV per cell.

Figure 1 **RS Dryfits A500 and A300 Charging voltage versus ambient temperature**



Dependence of the optimum final charging voltage for attaining full charge on extreme ambient temperatures. Dotted line = highest permissible, short time peak values, eg. a superimposed ac ripple.

Figure 2 **RS Dryfits A300 and A500 Charging time* versus charging current**



After being fully discharged the charging current can initially be 3A/Ah for several seconds and then decrease during the remaining charge period. It is therefore essential that current limiting is employed if smaller charge currents are required. The charge period can be calculated using Figure 2. When the charge current has settled and is say 0.3A/Ah then the total charge period will be approximately 5 hours.

When the battery is used for standby purposes only and the charger is permanently connected then the charging voltage may be reduced to a nominal 2.3V/cell. Such a charging voltage is often used in alarm control panels.

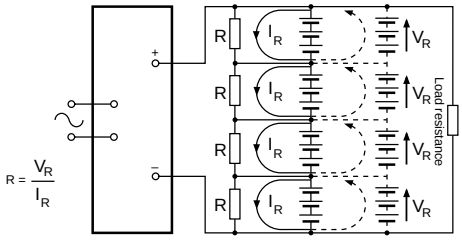
If the method of operation is entirely cyclic (dryfit A500 only), i.e. the battery is continually charged and discharged, then a slightly higher charging voltage may be used to achieve a shorter charging time. Under cyclic operation and at normal temperature a maximum charging voltage of 2.45V/cell (A500) is permissible provided that the battery never remains connected to the charger for longer than a week, and that charging current is limited to 0.5A per Ah maximum.

Charging methods

Series charging: Only recommended for batteries which have the same Ah capacity, state of charge and age. Normally these conditions only occur when the batteries are also discharged in series.

The recommended maximum number of cells that can be charged in series is limited to 12 i.e. giving a 24V battery. To maximise battery life this maximum should only be exceeded if some form of active voltage sensing and current sharing is applied on every 12 or 24V block of cells. With such precautions against overcharging of particular cells there is no limit to the number of series connected cells.

Figure 3 **Series/Parallel charging circuit Constant voltage current limited PSU**



Series/Parallel charging: For maximum life the batteries should be connected as in Figure 3. The resistors R should be matched to within 5% and have their values chosen to provide an IR of 5-10mA/Ah of the battery stack. It should be noted however that some practical tests have shown that there is little or an insignificant degradation in life if these precautions are not taken.

Parallel charging: Parallel charging should present no difficulties but due to the higher currents that can flow, care must be taken to allow for sufficient current from the charger. A circuit of a simple multi-range lead-acid cell charger is shown in Figure 20.

RS dryfits may be operated and stored in any position and are maintenance free. However, the possibility of charging equipment malfunction resulting in gassing should not be ignored. In the event of a build-up of gas pressure in the battery the automatically re-sealing safety valves ensure that this excess pressure can be immediately released. For this reason the valves must never be covered in an installation and batteries must not be enclosed within an unventilated enclosure. In fixed installations, care should be taken to ensure that these valves point upwards, ideally, or to the side. Severe overcharge can result in both gas and electrolyte being released. The presence of sparking components in the vicinity of the installed battery should be avoided.

Discharge performance

The self discharge rate of all dryfit types is low and long shelf-life is obtained (Figure 4) by storing in a suitable environment. When storing lead-acid batteries for a long time however, the state of charge should not be allowed to fall below the critical level and cyclic charging is recommended every 16 months. Batteries should not be stored permanently below –10°C.

The rated capacity of all dryfit A500 batteries is stated for a discharge current of I20 and for A300 for a discharge current of I10 (both at an ambient temperature of 20°C). It should be noted that the removable capacity is reduced when the discharge current is increased. Figure 5 shows this for the A300 types and Figure 6 shows this, and also the reduced capacity at lower temperatures, for the A500 types.

Figure 5 **RS Dryfit Percentage available capacity at different discharge currents**

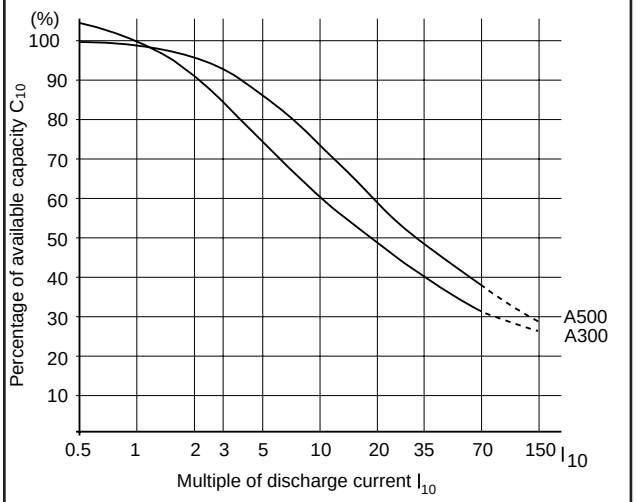
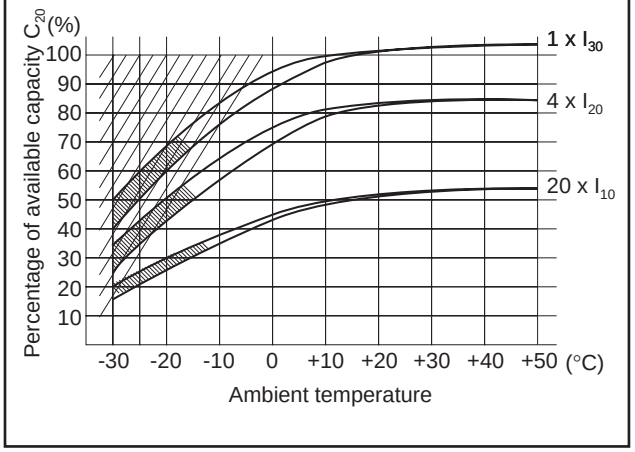


Figure 6 **RS Dryfit A500 Percentage available capacity at different temperature and load conditions.**



In open circuit, the fully charged dryfit battery has an ambient temperature-dependent voltage of between 2.10 and 2.15V/cell. Up to one day after charging, any residual gas loading of the plates will give a higher voltage, although after a longer period this will approach the values stated, or will quickly collapse under load.

The dryfit on load end point voltage will be 1.75V/cell at the C/10 rate for A300 types. This voltage however, will be significantly lower at higher discharge rates and this is clearly shown in Figure 7. Figure 8 gives the curves for A500 types.

Figure 7 **RS** Dryfit A300 End point voltage versus discharge time.

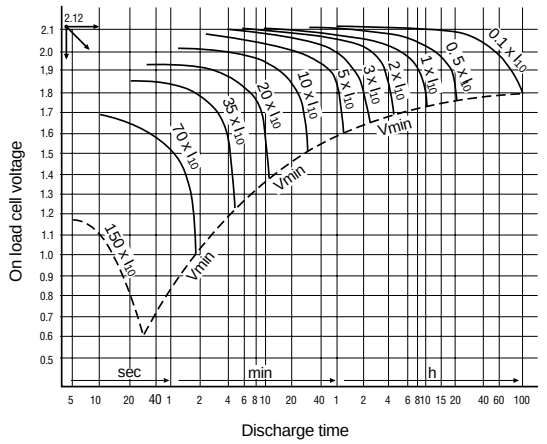
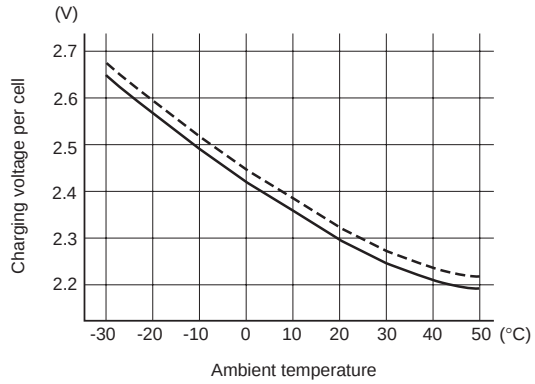


Figure 8 shows the minimum recommended voltage for a 2 Volt (nominal) cell dependant on load.

Figure 8 **RS** Dryfit A500 End point voltage versus discharge time

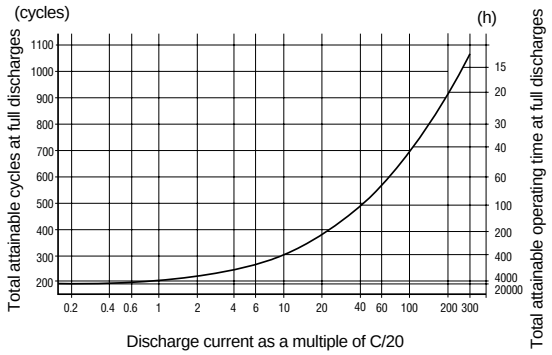


Dependence of the optimum final charging voltage for attaining full charge on extreme ambient temperatures. Dotted line = highest permissible, short time peak values, eg. a superimposed ac ripple.

Cyclic life

The cyclic life of a dryfit battery is dependent on the amount of capacity withdrawn during each discharge/ recharge cycle. Each dryfit A500 will deliver a total of 300 times its nominal capacity during its cyclic life, e.g. 300 cycles at 100% capacity withdrawn, 400 cycles at 50%, 2000 cycles at 10% and 20,000 cycles at 1%. The same rule can be applied to the 60 cycles at 100% of the dryfit A300. In addition to this the cyclic life of a dryfit increases with increased discharge current and this is clearly shown for the A500 in Figure 9.

Figure 9 **RS** Dryfit A500 Cyclic life versus discharge current



Note: Deep discharge of RS dryfits

When **RS** dryfits have been left connected to a permanently discharging load, or when the on load terminal voltage falls below V min. as given in Figures 7 and 8 then the battery is in a deep discharged condition.

Provided the battery is recharged within 4 weeks then no damage to the cell(s) will occur. However very low charge rates (5mA/Ah or less) and greatly extended charge periods (up to 72 hours or above) should be expected. It **may** still be possible to recover the battery from deep discharge conditions in excess of four weeks duration but the likelihood of damage from excessive discharging is minimised if the battery is put on charge as soon as possible. The A500 range is more resistant to deep discharge than most other types.

Pressure limits

The maximum pressure limit for dryfit batteries is 4 bar, equivalent, for example, to a water depth of 30m. Suitable precautions must, however, be taken to ensure in this type of application that no water can penetrate the valves and that no self discharge can occur via the live parts.

The minimum permissible pressure limit is 0.03bar, equivalent to a height of 30km, with the temperature not exceeding +25°C. At the short term permissible maximum temperature of +80°C, the minimum pressure limit is 0.3bar, corresponding to a height of 9.5km. Since ambient temperatures at altitude are generally extremely low, the resultant reduction in capacity shown in Figure 6 must be taken into account.

Sealed lead-acid batteries Yuasa endurance ranges

Endurance (EN) batteries are high capacity batteries designed for standby use in communication equipment. The cells offer high current for short periods of time. They require a continuous trickle charge when not discharging to maintain capacity. Supplied with connecting bars, nuts and bolts. The cells are usually linked together to become very high power larger batteries. Because of the unusually complex nature of these batteries we recommend contacting the **RS** technical helpline for further information.

Standard standby, NP range charging information

Suitable for standby or cyclic applications. We recommend charging these batteries from a constant voltage charger. Cyclic charging voltage is 2.5 volt per cell with a current limit of 0.25A per Ah capacity and 2.3 volt per cell for standby applications, with a current limit of 0.1A per Ah capacity. Charging voltage should be regulated in relation to ambient temperature (Figure 15). We do not recommend over discharging (deep discharge) NP batteries or storing in a discharged state. This could permanently damage the electrodes and destroy the battery.

Operational life

Usable life is directly affected by the number of discharge cycles, depth of discharge, ambient temperature and charging voltage. For cyclic use it is common practice to select a battery with a larger capacity than the one that is required to supply the expected load. Do not operate or charge in an unventilated space.

Figure 10 **NP range 20-hour rate capacity selection chart**

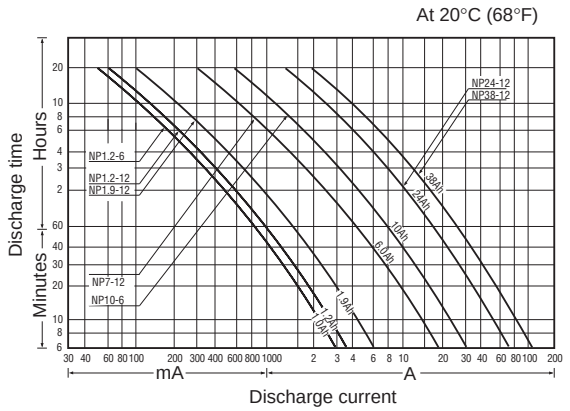


Figure 11 **NP discharge characteristic curves at 20°C (68°F)**

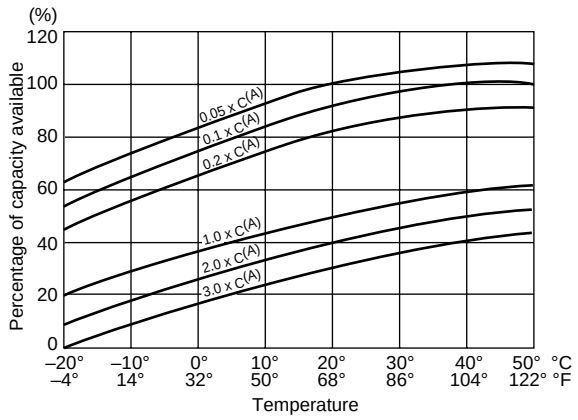
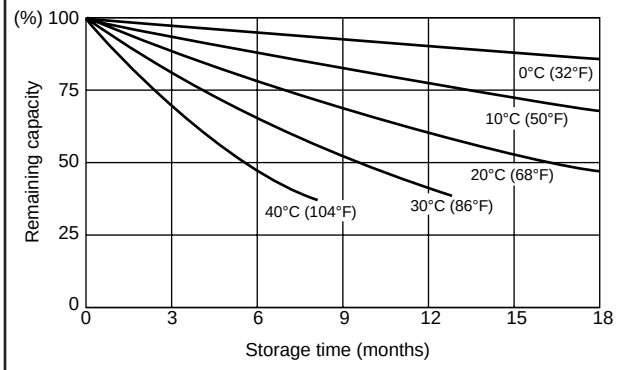


Figure 12 **NP range temperature effects in relation to battery capacity**



Self discharge

The self discharge rate of NP batteries is approximately 3% per month when stored at an ambient temperature of 20°C. The self discharge rate will vary as a function of ambient storage temperature Figure 13 shows the relationship between storage times at various temperatures and the remaining capacity.

Figure 13 **NP range self discharge characteristics**

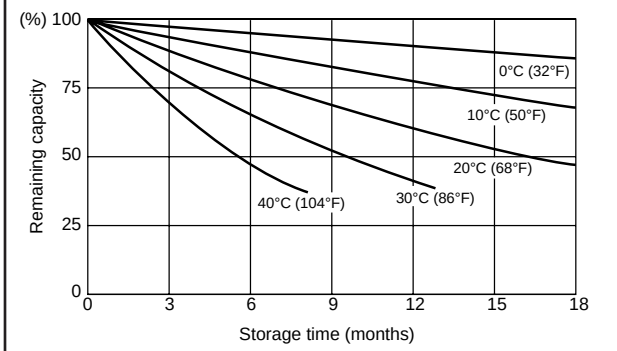


Figure 14 **NP range charging characteristics**

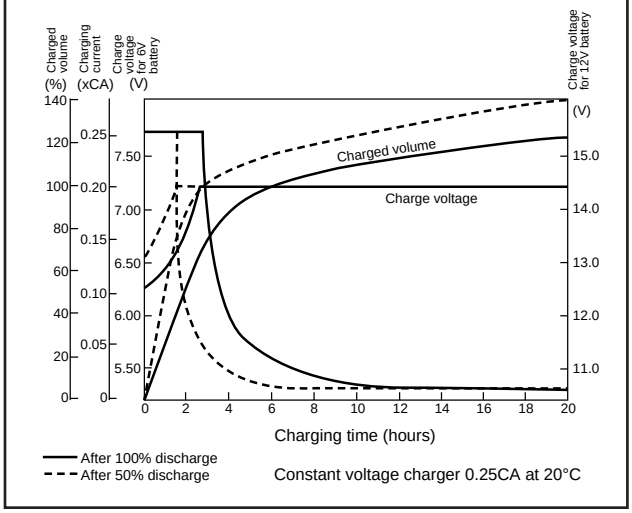
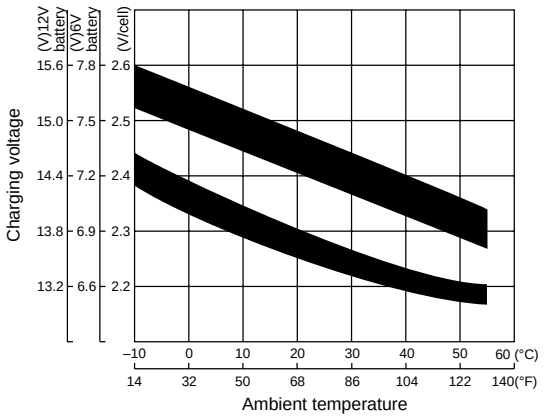


Figure 15 **NP range relationship between charging voltage and temperature**



Lead-acid **RS** Cyclon

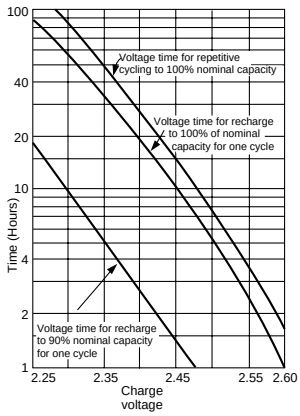
Charging information

These batteries may be charged either constant voltage or constant current. They should not be charged in a gas tight container.

Constant voltage charging is the most efficient and fastest way to charge the **RS** Cyclon. The constant voltage should be between 2.30 and 2.55V/cell with the appropriate charge times for a 100% discharged cell given in Figure 16.

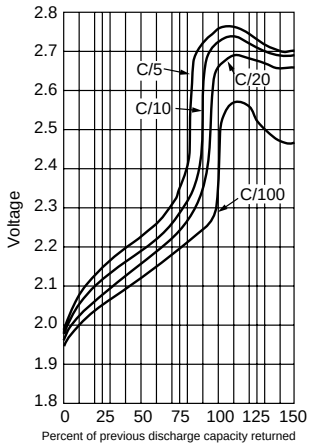
Note: The curves apply to a charger capable of giving charge rates in excess of 2C (i.e. 5A for each 2.5Ah cell, 10A for each 5.0Ah cell and 50A for each 25A cell connected in parallel). For chargers with charge rates less than 2C the charge times given in Figure 16 should be increased by approximately the hourly rate at which the charger is limited i.e. if the charger is limited to the C/10 rate then 10 hours should be added to each of the charger voltage/time relationships; if the charger is limited to the C/5 rate then 5 hours should be added etc.

Figure 16 **RS Cyclon Charge voltage against time on charge at 23°C**



Float charging; the recommended voltages can vary between 2.30 and 2.40V/cell. Depending on battery voltages the following charge voltages are recommended: 2.35V/cell up to a 12V battery; 2.38V/cell up to a 50V battery; 2.4V/cell up to a 110V battery. Lower charge voltages may be used if longer recharge times are acceptable.

Figure 17 **RS Cyclon Voltage curves for constant current charge rates at 23°C**



Cyclic charging for cyclic charging of 2.5Ah and 5.0Ah cells, voltages between 2.40 and 2.55V/cell may be selected. The time duration of the charge can be determined from Figure 16. Figure 21 gives circuit details for a suitable constant voltage charger.

Constant current charging is particularly effective when many cells are to be charged in series. It tends to eliminate any charge imbalance in a battery stack as it is independent of the charge voltage of the cell.

The recommended indefinite constant current charge is C/500. The battery can be charged at higher rates but voltage or time limitation must be used for rates in excess of this (Figure 17).

Figure 18 **RS Cyclon Open circuit terminal voltage versus capacity**

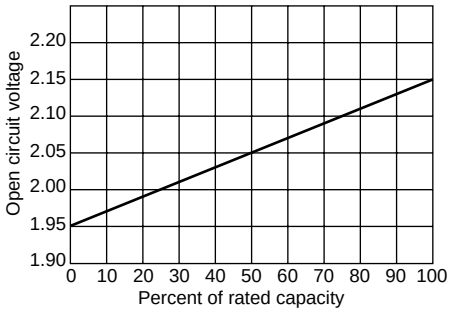
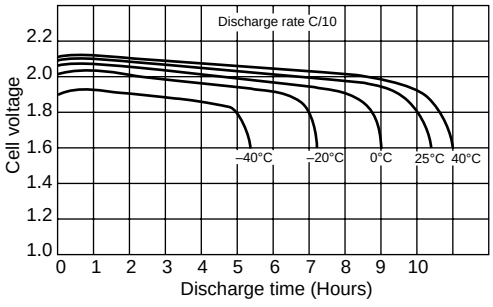


Figure 19 **RS Cyclon End point voltage versus discharge time**



Discharge performance

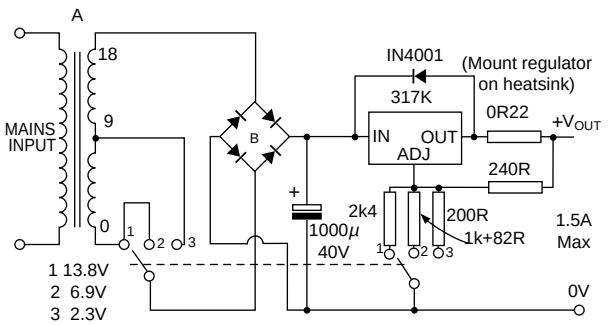
The Cyclon cell has a low self discharge rate. An indication of the state of charge can be obtained by monitoring the open-circuit terminal voltage. Figure 18 shows a curve of this voltage versus capacity for a Cyclon cell as 23°C, with the capacity being that available at the C/10 rate of discharge. The returned capacity of the Cyclon is dependent on temperature and Figure 19 shows the discharge characteristics for C/10 discharge rate at various temperatures.

Note: Deep discharge of RS Cyclons

When **RS** Cyclons have been left connected to a permanently discharging load or the terminal voltage on load falls below 1.6V (at C/10 rate) the cell is then in a deep discharge state. Recovery from this state without cell damage is possible if the cells are recharged immediately. Very low initial charge rates and greatly extended charging periods are likely to be experienced under these conditions.

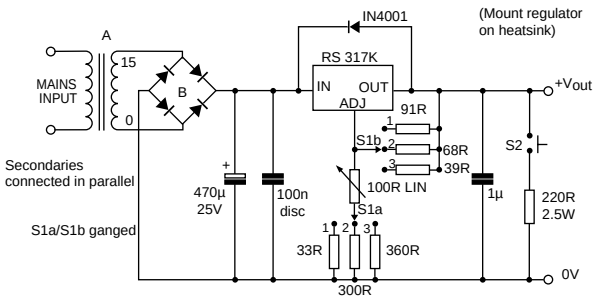
Circuits for lead-acid battery chargers

Figure 20 **Simple multi-range A300 lead-acid battery charger**



A = **RS** stock no. 207-582
B = **RS** stock no. 296-346

Figure 21 **Constant voltage charger for RS Cyclons**



S1 position	No. of cells	Vout range (typ)	Select S1 position,
1	1	1.8V – 3.1V	Close S2 momentarily and
2	3	6.85V – 8.6V	Adjust 100R pot to give required
3	6	12.9V – 16.0V	Voltage output (see fig. 12)

A = **RS** stock no. 208-793
B = **RS** stock no. 296-346

Nickel-cadmium batteries and cells

All types of nickel-cadmium batteries and cells can be charged and discharged in any position and can be satisfactorily used in comparatively hostile environments. Unlike lead-acid batteries NiCds can be stored for periods in excess of 5 years without the need for periodic recharging to ensure good life. All cells and batteries are supplied holding only a residual charge and will therefore usually require a full charge before use. Cells can be potted provided the temperature does not rise above 50°C (60°C short term) during the potting stage. The vent in the top of the case **must** have an escape to atmosphere to allow the escape of gas in case of abuse.

The memory effect

This is a problem that occurs when a battery is constantly recharged when it has not been completely discharged. In voltage critical applications it is most apparent as the cell loses voltage too quickly. Basically this effect can be avoided by ensuring thorough discharging of NiCds before charging. If this is not done cells can be damaged in charging. Because of retained charge the predicted charge time will be too long, the cell can continue into overcharge on manually timed chargers.

Charging information

It is recommended that NiCd cells are charged from a constant current source only. Non constant current charging is only permissible if the recommended continuous charge rate is not exceeded once the cell has reach a fully charged state.

Normal charging

The normal charge rate for standard sintered cells and high temperature sintered cells is C/10, i.e. for a 4Ah cell this represents a charging current of 400mA. At this charge rate the cell will fully charge in approximately 16 hours (i.e. when the charge equivalent of 160% of the Ah capacity has been returned to the cell).

Higher charge rates, which result in an accelerated charge, are permitted for sintered cells. The PP9 has a maximum charge rate of 2C, the high temp cells have a charge rate of C/10, the N and AAA cells have a maximum charge rate of C/4 and the remainder of the sintered types have a maximum rate of 10C. For charge rates of C or greater the cell should be fully discharged prior to recharging. The cell should then be charged for the time shown in Figure 22. Thus for a 4Ah standard D cell charged at the 8C rate (32A) the total charging time, which must not be exceeded, is 5 minutes.

When fast charging adequate ventilation must be arranged in order to allow any gases which may be generated to escape. All the sintered cells are fitted with an automatically re-sealing safety vent which will operate under conditions of charge abuse. When charging at low rates it should be noted that sintered cells have a minimum charge acceptance rate of C/40.

The multi-range constant current charger (**RS** stock no. 591-067) can be considered a suitable charger for some specialist cell sizes ($^{1}/_{2}$AA, $^{1}/_{2}$A, RR and $^{1}/_{2}$D) and the high capacity cells. Table 4 shows the current setting and the appropriate charge time for a completely discharged cell.

Table 4

Battery type	RS stock no.	Current setting on charger (RS stock no. 129-690)	Charge time
1/2AA	229-093	45mA (~C/5)	8.5h
1/2A	228-034	45mA (~C/10)	16h
RR	592-363	100mA (~C/14) 150mA (~C/9)	22.5h 15h
1/2D	229-166	150mA (~C/16) 150mA (~C/7)	25.5h 11h
AA	598-664 598-692	45mA (~C/16) 100mA (~C/7)	25h 11h
RR	594-662	150mA (~C/11) 350mA (~C/5)	18h 6.5h
Af	849-473	100mA (~C/10) 150mA (~C/7)	16h 10.5h
2/3AA	594-684	45mA (~C/13) 100mA (~C/8)	21h 9.5h

The nickel cadmium mass plate cells and batteries have lower recommended maximum charge rates (C/10) than sintered cells because of their plate construction. They are however ideal for use under continuous trickle charge conditions, e.g. memory back-up supply applications, having a recommended continuous charge rate of C/50. At the maximum charge rate of C/10 the cells will be fully charged in approximately 14 to 16 hours. Although fully charged after this time the charging period can be extended by up to 300% without damage to the cells.

A typical general purpose charging circuit for NiCd batteries and cells is shown in Figure 29.

The primary use of the PCB batteries is to provide on board CMOS or NMOS volatile memory support in the event of main supply failure. The circuit shown in Figure 30 is a simple, permanently connected, circuit for trickle charging the 3.6V battery from the logic supply. Diode D1 protects the power supply regulator in the event of an ac mains supply failure and may be omitted if protection is already provided.

Discharge information

NiCd cells exhibit a relatively flat voltage/time discharge characteristic which is dependent on the discharge current. Except at higher discharge rates the end point voltage is usually taken to be 1.0V. Typical discharge curves are shown for sintered and mass plate cells in Figures 23 and 24 respectively.

Figure 22 **Charge period versus charge rate**

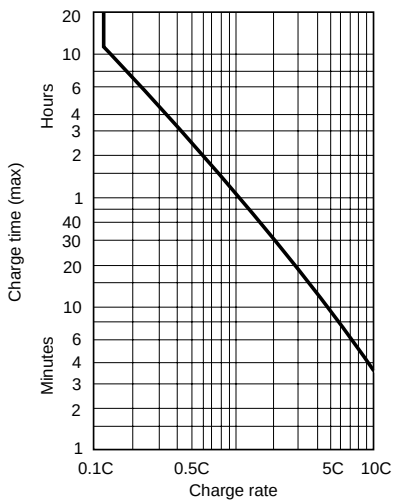


Figure 23 **Typical sintered cell discharge times versus cell voltage for different discharge rates**

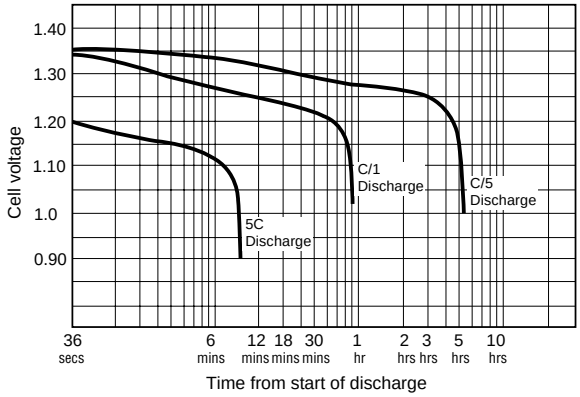
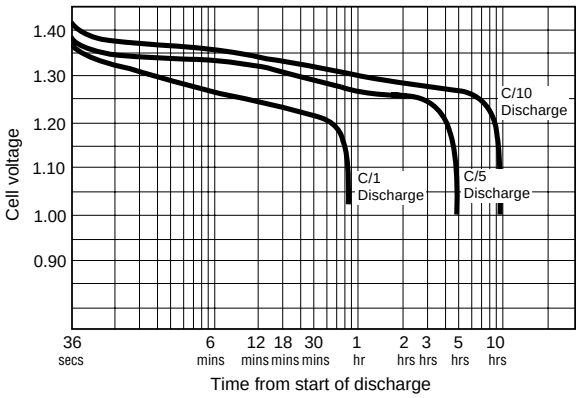


Figure 24 **Mass plate cell discharge time versus cell voltage for different discharge rates**



When discharging NiCd cells in series care must be taken not to allow the voltage to fall below 1V/cell when discharging at rates greater than C/5 (sintered cells) or C/10 (mass plate cells) as damage may occur due to a cell being reverse charged.

The construction of sintered cells is such that they have a relatively low internal resistance and therefore considerable maximum discharge currents can be obtained (Table 3).

The on charge voltage is between 1.4 and 1.5V per cell, falling to an average of 1.25V during discharge.

High temperature applications

For applications where higher ambient temperatures are likely to be experienced the high temperature sintered D cells and battery packs offer the best solution. Although standard cells can be charged and discharged at temperatures up to 45°C and 50°C respectively the charge acceptance and charge retention properties of the cells at these temperatures may be affected resulting in reduced capacity. Certainly at temperatures above 50°C the reliability and capacity of standard sintered cells is degraded by oxidation of the electrodes and degradation of the non woven separator material. The high temperature cells use special electrodes and polypropylene separators to minimise these effects. They exhibit a good charge acceptance at elevated temperatures (Figure 25) and improved charge retention, i.e. self discharging performance (Figure 26) compared with standard sintered cells (Figure 27). It should be noted however that mass plate cells have better self discharge figures than any of the sintered plate types (Figure 28).

Figure 25 **Charge acceptance of high temp. cells – achievable capacity versus charge rate**

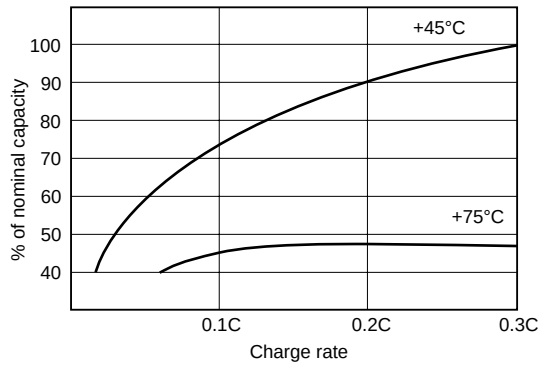


Figure 26 **Capacity versus time at different temperatures for high temp. cells**

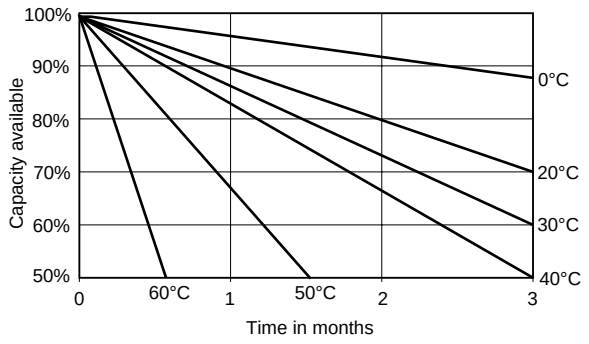


Figure 27 **Capacity versus time at different temperatures for standard sintered cells**

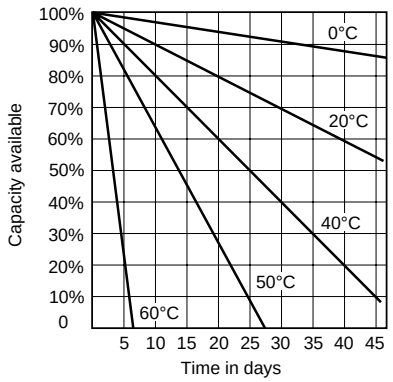


Figure 28 **Capacity versus time at different temperatures for mass plate cells**

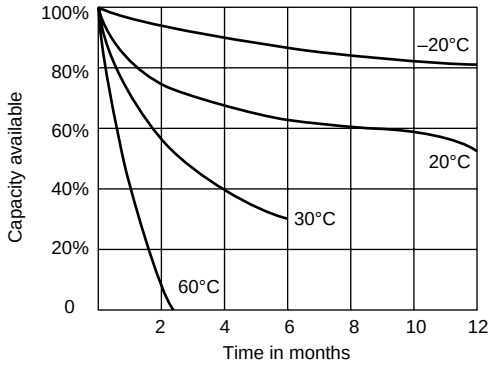
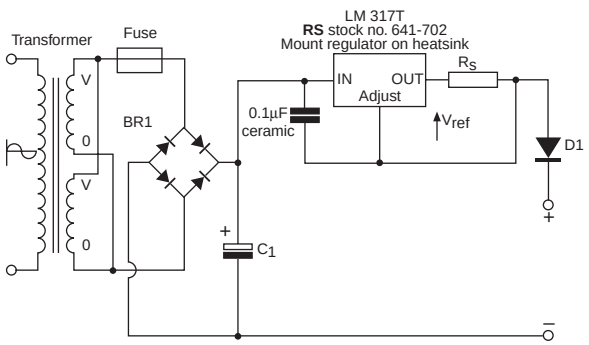


Figure 29 **NiCd battery charger**



BR1 **RS** stock no. 183-4078 (2A max.)

Fuse Anti-surge (T), spiral wound construction, to suit required output current.

C1 4700µF 25V, (e.g. **RS** stock no. 106-186).

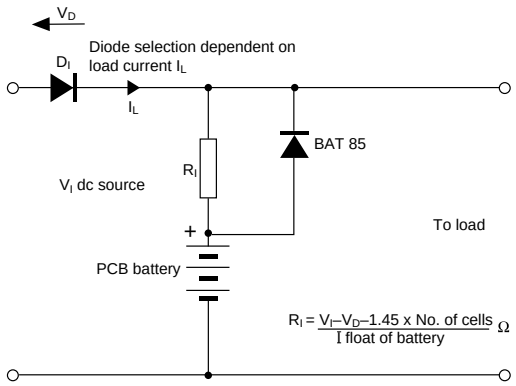
D1 1N 4001 (**RS** stock no. 261-148), or 1N 5401 (**RS** stock no. 261-299) for super F.

RS = $\frac{V_{ref}}{I_{out}}$ V_{ref} = 1.2V nominal. See Table 5 for some common values.

Transformer **RS** stock no. 210-774 will supply up to 300mA for stacks up to 4.8V. **RS** stock no. 210-780 can supply 140mA at up to 12V. **RS** stock no. 208-715 will satisfy low voltage high current applications and **RS** stock no. 207-144 can be used for 12V stacks charged at one amp or more.

NiCd size	RS stock no.	Charge time	Current	R_S (nominal) Ω 0.25W unless otherwise specified
PP9	229-059	16h	120mA	10
N	592-026	15h 6h	15mA 38mA	82 33
AAA	591-146	15h 6h	18mA 45mA	68 27
C	228-028	16h	220mA	5.6 (0.5W min.)
D	229-065	16h	400mA	3.3 (0.5W min.)
½AA	229-093	16h	24mA	51
½A	228-034	16h	45mA	27
RR	592-363	16h	140mA	9.1
½D	229-166	16h	240mA	5.19 (or)5.6 (0.5W min.)
F	229-122	16h	700mA	1.87 (1W min.)
Super F	229-138	16h	1A	1.2 (2.5W)
AA high cap.	598-664 598-692	16h	80mA	15
RR high cap.	594-662	16h	170mA	6.8
A_f high cap.	849-473	16h	100mA	12
2/3A_f high cap.	594-684	16h	60mA	20
10 x AA	321-509	5-6h	150mA	8.2
10 x C	321-515	16h	230mA	5.9 (0.5W min.)
20 x AA	596-107	5-6h	150mA	8.2
5 x AA	596-129	5-6h	150mA	8.2
20 x RR	596-135	5-6h	350mA	3.9 (0.5W min.)

Figure 30 **Charger for 3.6V PCB battery**



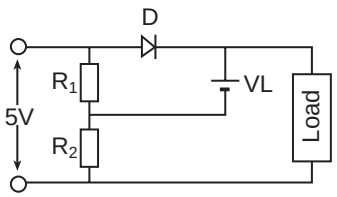
Vanadium pentoxide lithium cells

High energy rechargeable cells, ideal for use as a 3V battery backup power source. The solder tags are laser welded to the cell. Wave soldering of charged cells is permitted, provided the cell does not exceed 95°C. Vapour phase or infra red reflow soldering should not be used.

The charging circuit for cells must be designed so that the shorting or opening of any protective component, one component at a time, will not result in a charging current in excess of 300mA.

A typical charging circuit is shown below.

Figure 31



	Load Current			
	100µA - 200µA		Less than 100µA	
	ΔVaccross D, 0.2-0.6V		ΔVaccross D, <0.2V	
	R_1	R_2	R_1	R_2
VL 1220	2000Ω	510	1500Ω	560Ω
VL 2020	1300Ω	330Ω	470Ω	180Ω
VL 2320 / 2330	1110Ω	270Ω	390Ω	150Ω
VL 1220	510Ω	120Ω	180Ω	68Ω

Charging

For constant voltage charging the voltage should not exceed 3.4V. When overcharged the internal resistance will rise leading to cell deterioration.

For constant current charging keep to the rated charging current. Avoid trickle charging the cell as it will cause cell deterioration.

Do not connect the cells in series.

As the cells reach the end of their useful life the cells internal resistance will rise dramatically. This should be taken into consideration when designing a circuit. Do not disassemble, expose to water or excess heat. Do not short circuit.

Figure 32 **Duration as a function of load current**

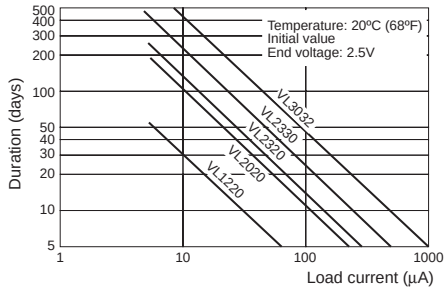


Figure 33 **Discharge characteristics VL**

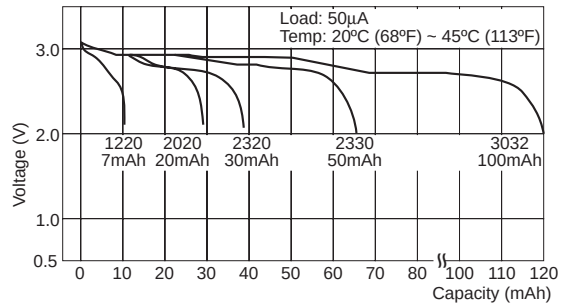
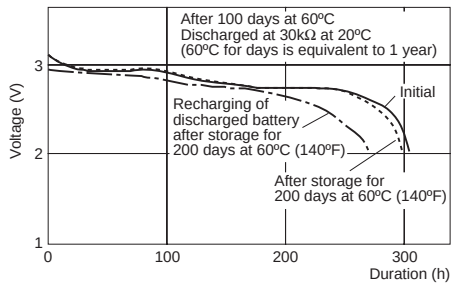


Figure 34 **Storage characteristics (without charging) VL2020**



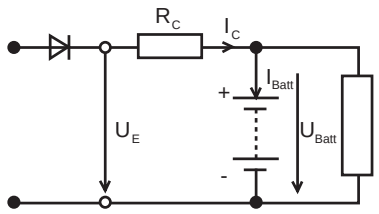
Nickel metal hydride cells

Nickel metal hydride cells are constructed from mass plate electrodes (thin pressed tablets) enclosed in a conductive nickel wire gauze material. The positive electrode consists of nickel hydroxide and the negative electrode is metal hydride (a hydrogen storage alloy), rather than the cadmium used in NiCd cells. The button shaped steel casing is hermetically sealed. The punched positive sign on the cell is used as a pressure relief vent.

Charging

Charge NMH cells using constant current charging. Standard charge is 0.1CA for 14 hours. For accelerated charging use 0.2CA for 7 hours. In many applications these cells are trickle charged at 0.03CA. Charging these cells in parallel must be avoided.

Figure 35 **Trickle charge**



$$R_C = \frac{U_E - U_{Batt\ Max.}}{I_C}$$

Figure 36 **Typical discharge curve at various temperatures**

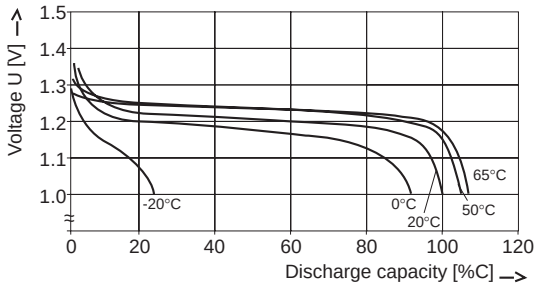
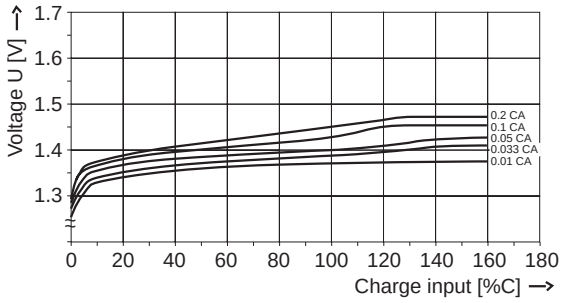


Figure 37 **Typical charging curve at 23°C**



RS Components, PO Box 99, Corby, Northants, NN17 9RS
An Electrocomponents Company
Telephone: 01536 201234