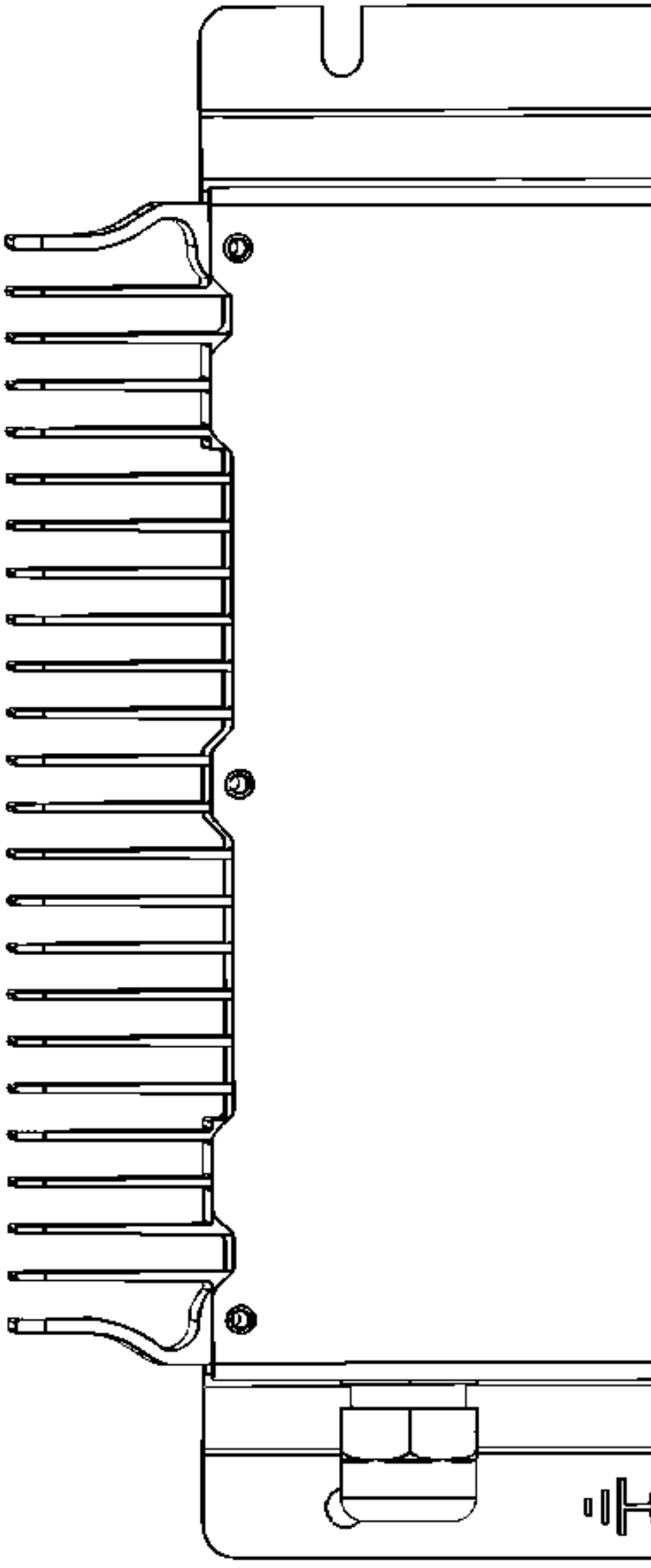
Battery Charge Algorithm Descriptions



delta-q TECHNOLOGIES

710-0088 R2

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Introduction

One of the QuiQ charger's most powerful features is the ability to perfectly charge many different types of batteries. All that is required is that the appropriate algorithm be selected. The QuiQ charger has memory space for 10 algorithms onboard, one of which will be the default. This document describes the differences between some of the most commonly used algorithms.

Temperature Compensation

The algorithms presently available are divided into two groups (see Algorithm List for details):

A. Temperature Compensated		B. Not Temperature Compensated	
1	Trojan T105	**3**	T105 dV/dt Constant Power
2	Trojan T105 Tapped	**7**	J305 dV/dt Constant Power
5	Trojan 30/31XHS	**11**	generic 225Ah dV/dt
6	DEKA 8G31 Gel	**21**	Exide flooded dV/dt
8	Concorde 1xxAh AGM	**23**	Douglas flooded dV/dt
12	Exide 240Ah Gel	**37**	Flooded 42V Battery Pack (T105) dV/dt
26	DEKA 8GGC2 Gel	**62**	Trojan 100Ah flooded dV/dt
27	Large flooded battery pack (Crown 325)	**71**	generic 150Ah dV/dt
35	Concorde 2xxAh AGM	**72**	generic 300Ah dV/dt
38	Trojan T1275	**73**	generic 400Ah dV/dt
42	Discover 80Ah – 150Ah AGM		
43	Discover 200Ah – 400Ah AGM		
51	Exide 180Ah Gel		
52	Exide 105Ah Gel		
87	generic 40 – 80Ah AGM		

A. Temperature Compensated

These algorithms must be used with a battery temperature sensor. If one is not installed, the white wire from the charger *must* be connected to ground so that the charger will use a default temperature of 25.0°C. Note that this may lead to under- or over- charging in temperature extremes, and could lead to battery damage.

Algorithm	$T_{nominal}$	Coef below $T_{nominal}$	Coef above $T_{nominal}$
8, 35	25.0°C	-0.005 Vpc / °C	-0.0026 Vpc / °C
1, 2, 5, 27, 38	26.7°C	-0.005 Vpc / °C	
6, 26	20.0°C	-0.005 Vpc / °C	
12, 51, 52	30.0°C	-0.004 Vpc / °C	
42, 43, 87	25.0°C	-0.005 Vpc / °C	

Table 1 - Temperature compensation coefficients.

B. Not Temperature Compensated

These algorithms can be used without a battery temperature sensor. However, it is still recommended that the white wire be connected to ground.

Other Features (all algorithms)

Deep Discharge Recovery: Trickle pack at 5A (max 18.0hrs) until 2.0Vpc, then begin charge
Note: 2.0A for Algorithm #42
3.0A for Algorithm #62

Maintenance Mode: Restart charge every 30 days or if < 2.08Vpc

Algorithms 1, 2, 5 and 38: Temperature-Compensated Charging for Trojan Flooded Batteries

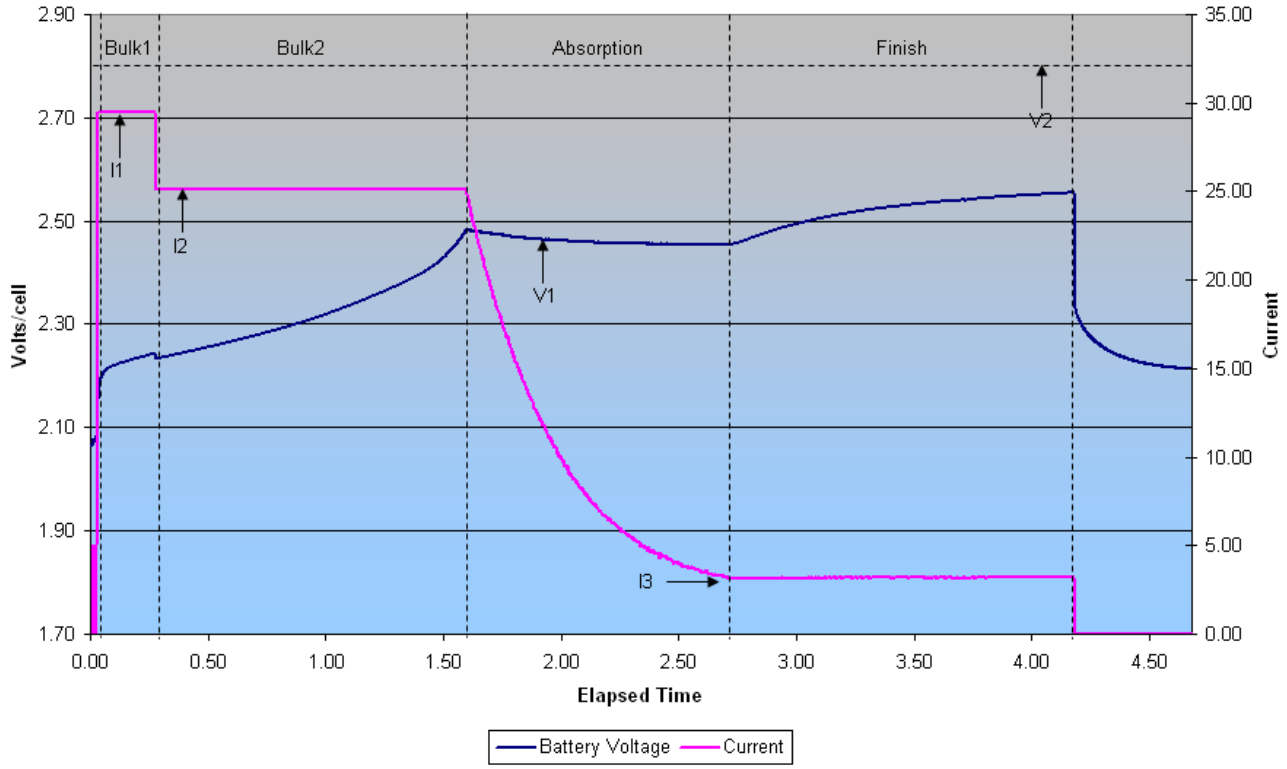

Figure 1 - Sample Charge Cycle.

This group of algorithms terminates when the target overcharge has been met. As a safety precaution during the *Finish* phase, if the battery voltage ever exceeds *V2* the charge cycle is terminated.

Algorithm	I1	I2	V1	I3	Overcharge	V2
1	Max – Pulse	Max	2.43 Vpc	4.5 A	110%	2.80 Vpc
2	Max – Pulse	Max	2.43 Vpc	4.5 A	120%	2.80 Vpc
5	Max – Pulse	Max	2.43 Vpc	2.0 A	110%	2.75 Vpc
38	Max (no Pulse)	Max	2.43 Vpc	4.0 A	113%	2.80 Vpc

Table 2 - Charge setpoints for algorithms 1, 2, 4, 5, and 38.

Algorithm	Bulk 1	Bulk 2	Absorption	Finish	Overall
1	15.0 min	18.0 hrs	6.0 hrs	5.0 hrs	29.25 hrs
2	15.0 min	18.0 hrs	6.0 hrs	8.0 hrs	32.25 hrs
5	15.0 min	13.0 hrs	5.0 hrs	5.0 hrs	23.25 hrs
38* **	Not used	12.0 hrs	5.0 hrs	4.0 hrs***	16.0 hrs***

Table 3 - Charge timeouts for algorithms 1, 2, 4, 5 and 38.

***** Algorithm 38 has a 1 in 32 chance of entering an Equalize mode. This forces an additional 4.0 hrs of Finish, extending the Finish timeout to 8.0 hrs and the overall timeout to 24.0hrs.**

Algorithms 3, 7, 21, 23, 37***, and 62: dv/dt Finish Charging for Flooded Batteries

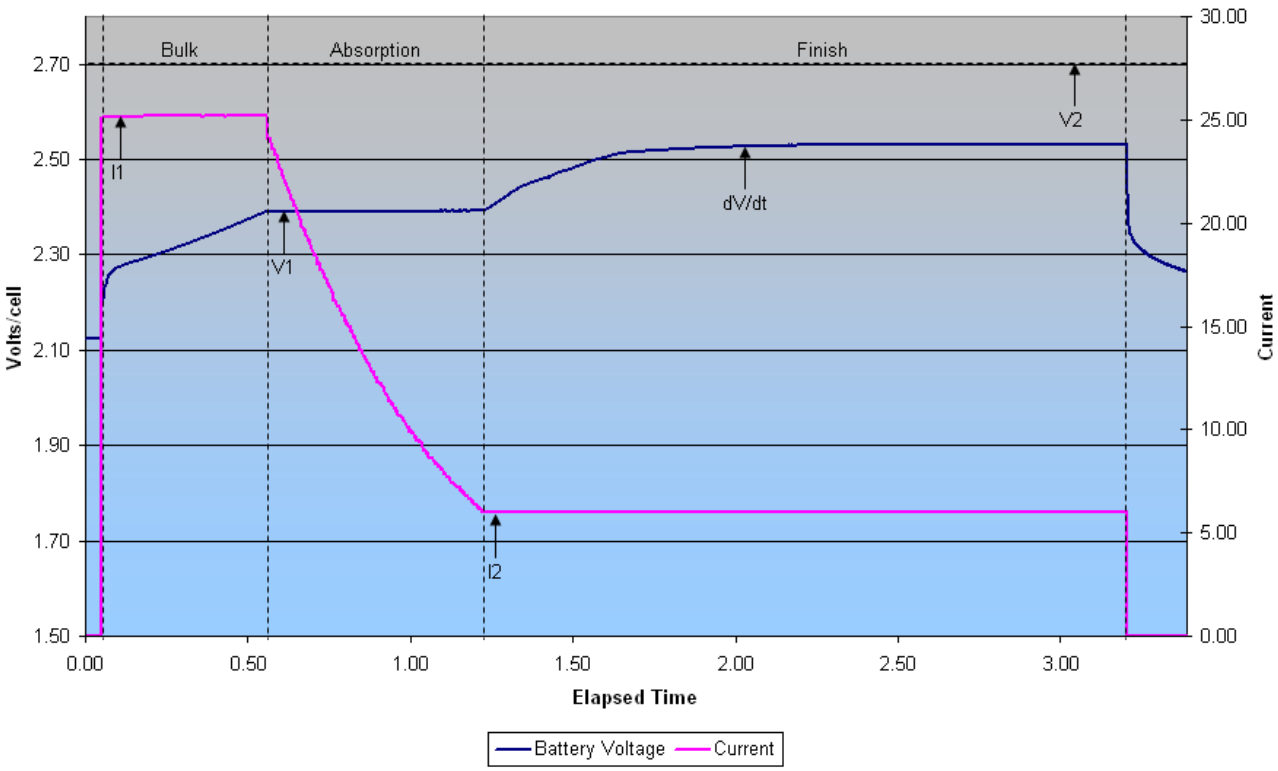

Figure 2 - Sample charge cycle for algorithm 23.

This group of algorithms uses a *dV/dt* termination criterion, checked every hour during the *Finish* phase. As a safety precaution during the *Finish* phase, if the battery voltage ever exceeds *V2* the charge cycle is terminated.

Algorithm	I1	V1	I2	dV/dt	V2
3	Max	2.35 Vpc	6.0 A	< 0.035 Vpc/hr	2.70 Vpc
7	Max	2.35 Vpc	9.3 A	< 0.035 Vpc/hr	2.70 Vpc
21	Max	2.40 Vpc	10.0 A	< 0.037 Vpc/hr	2.80 Vpc
23	Max	2.40 Vpc	6.0 A	< 0.010 Vpc/hr	2.70 Vpc
37* **	Max	2.35 Vpc	6.0 A	< 0.035 Vpc/hr	2.70 Vpc
62	Max	2.35 Vpc	3.0 A	< 0.035 Vpc/hr	2.70 Vpc

Table 4 - Charge setpoints for algorithms 3, 7, 21, 23, 37, and 62.

Algorithm	Bulk	Absorption	Finish (min/max)	Overall
3, 7, 23, 37, 62	18.0 hrs	6.0 hrs	1.0 hrs / 6.0 hrs	24.0 hrs
21	15.0 hrs or 225Ah	6.0 hrs	none	21.0 hrs

Table 5 - Charge timeouts for algorithms 3, 7, 21, 23, 37 and 62.

***** Algorithm 37 is intended for 42V battery packs running on a 48V charger. Will also work with a 84V pack on a 96V charger.**

Algorithms 8 and 35: Constant Voltage Charging for AGM Batteries

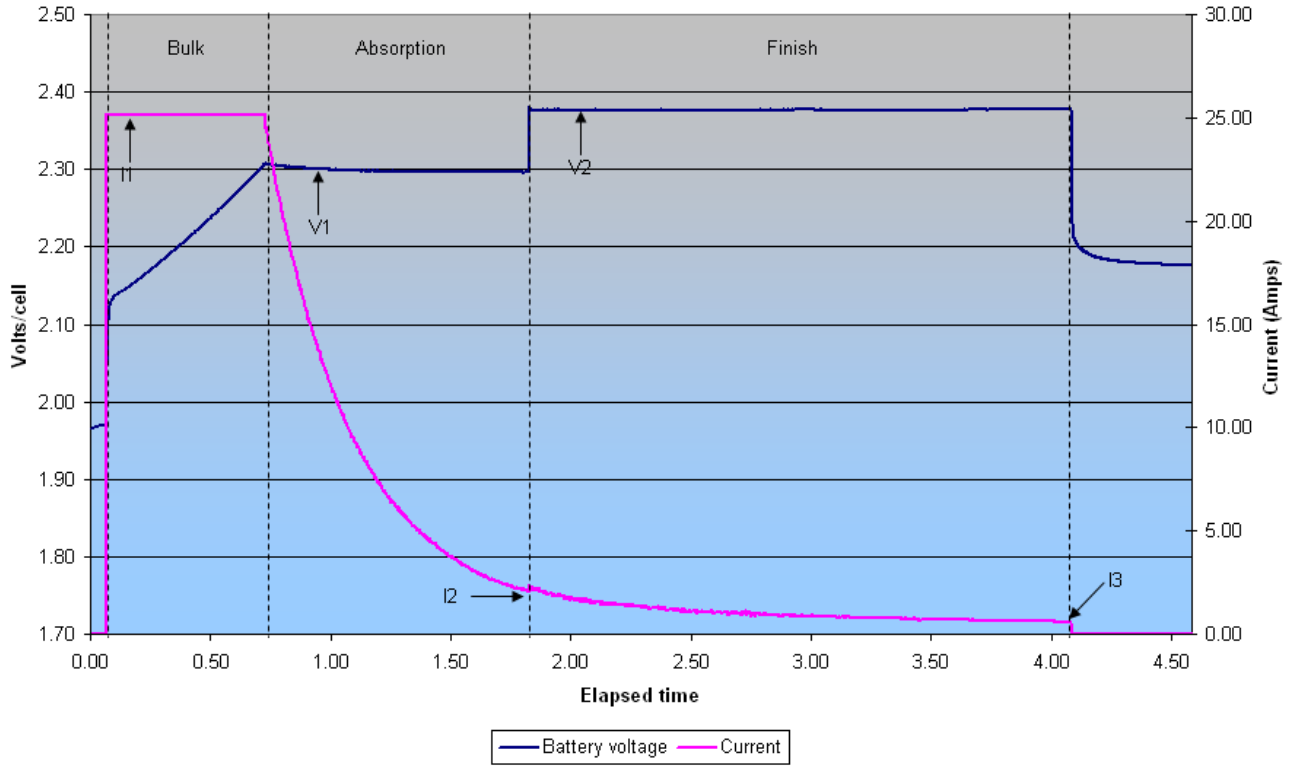

Figure 3 - Sample charge cycle for algorithm 8.

This group of algorithms uses a minimum current termination criterion, according to Concorde's specifications. The termination criterion is more complicated than it appears in Figure 3, and it is possible to terminate before the current tapers to *I3*.

Algorithm	I1	V1	I2	V2	I3
8	Max	2.30 Vpc	2.1 A	2.38 Vpc	0.5 A
35	Max	2.30 Vpc	4.7 A	2.38 Vpc	1.2 A

Table 6 - Charge setpoints for algorithms 8 and 35.

Algorithm	Bulk	Absorption + Finish (min/max)	Overall
8	10.0 hrs	1.0 hrs / 8.5 hrs	22.0 hrs
35	23.0 hrs	1.0 hrs / 8.5 hrs	22.0 hrs

Table 7 - Charge timeouts for algorithms 8 and 35.

Algorithm 27: Raised Finish Charging for Flooded Batteries

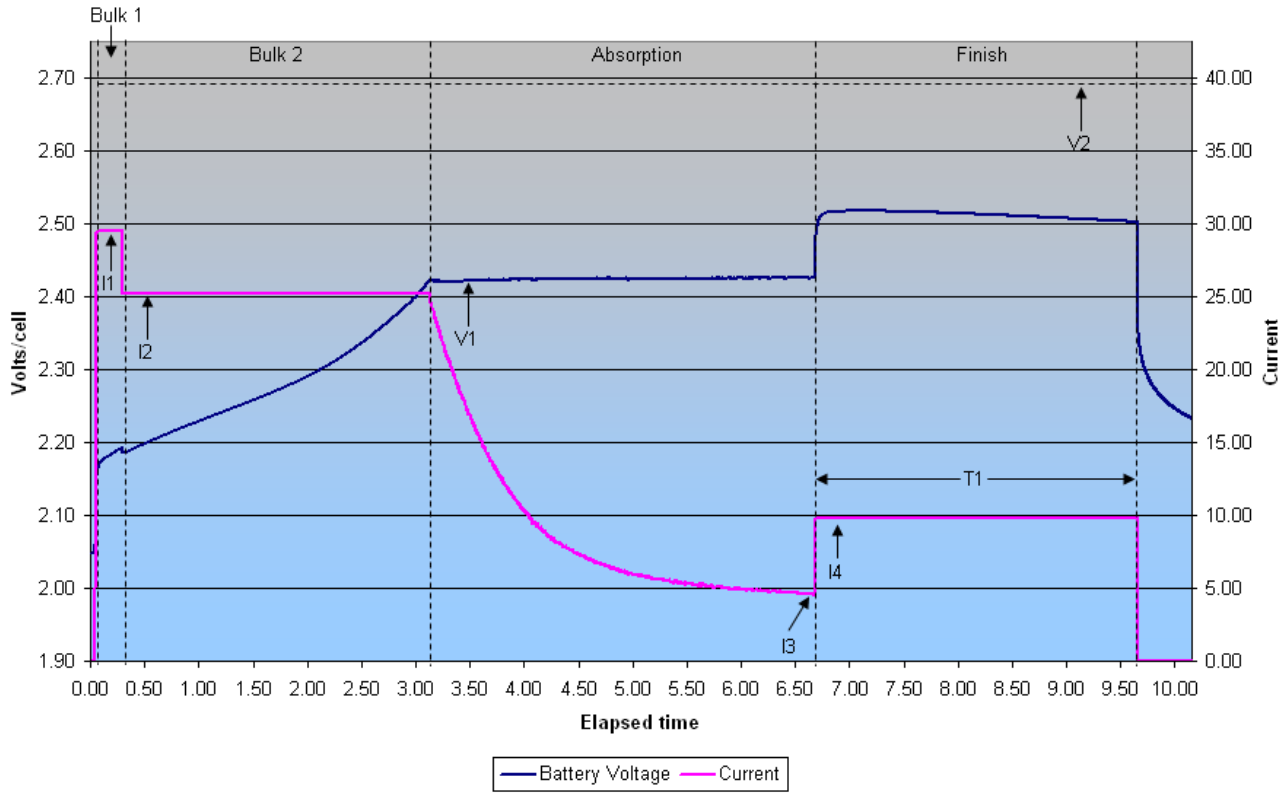

Figure 4 - Sample charge cycle for algorithm 27.

This algorithm terminates based on a current threshold and a timeout. As a safety precaution during the *Finish* phase, if the battery voltage ever exceeds *V2* the charge cycle is terminated.

Algorithm	I1	I2	V1	I3	I4	V2
27	Max – Pulse	Max	2.43 Vpc	4.5 A	9.8 A	2.70 Vpc

Table 8 - Charge setpoints for algorithm 27.

Algorithm	Bulk 1	Bulk 2	Absorption	Finish (T1)	Overall
27	15.0 min	18.0 hrs	6.0 hrs	3.0 hrs	27.25 hrs

Table 9 - Charge timeouts for algorithm 27.

Algorithms 11, 71, 72, and 73: Generic dv/dt Charging for Flooded Batteries

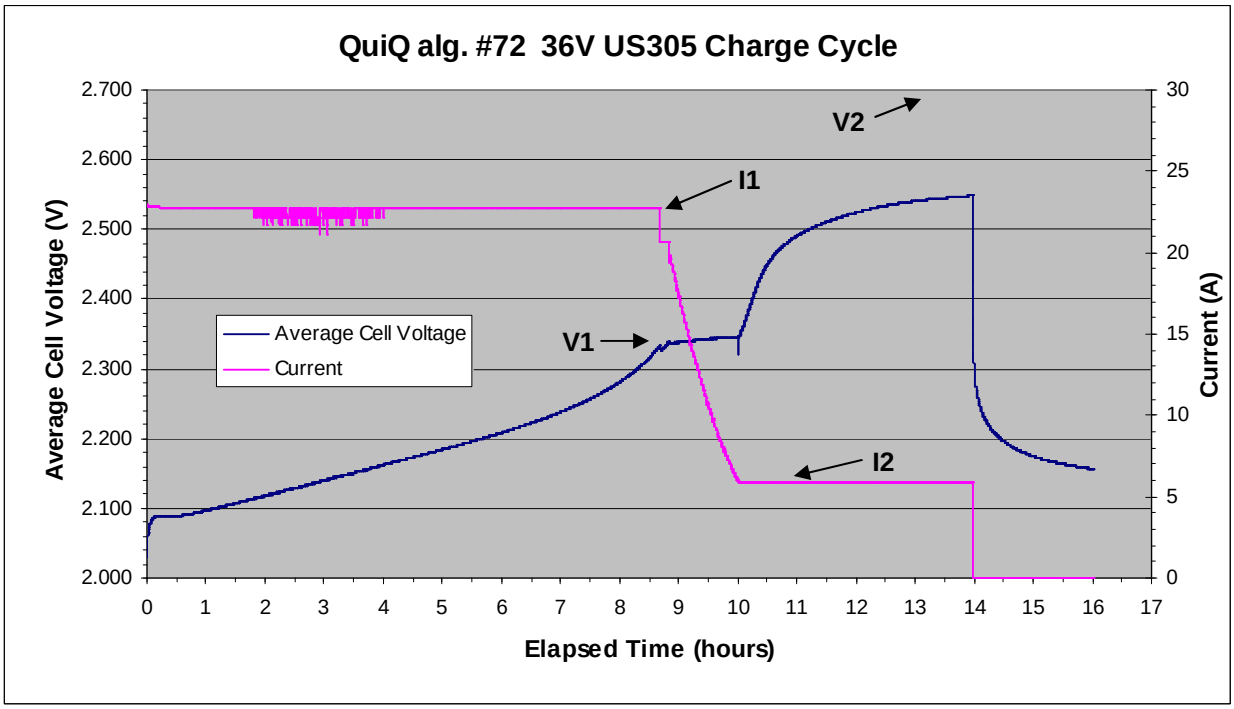

Figure 5 - Sample charge cycle for algorithm 72.

This group of algorithms uses a more strict *dV/dt* termination criterion, checked every hour during the *Finish* phase. As a safety precaution during the *Finish* phase, if the average cell voltage, or volts per cell (Vpc), ever exceeds *V2* the charge cycle is terminated.

Charge Setpoints

Algorithm	I1	V1	I2	dV/dt	V2
11 200-255Ah Flooded	Max	2.35 Vpc	5.0 A	< 0.010 Vpc/hr	2.70 Vpc
71 140-200Ah Flooded	Max	2.35 Vpc	3.5 A	< 0.010 Vpc/hr	2.70 Vpc
72 250-335Ah Flooded	Max	2.35 Vpc	6.0 A	< 0.010 Vpc/hr	2.70 Vpc
73 400Ah Flooded	Max	2.45 Vpc	8.5 A	< 0.010 Vpc/hr	2.70 Vpc

Table 10 - Charge setpoints for algorithms 11, 71, 72, and 73.

Charge Timeouts

Algorithm	Bulk	Absorption	Finish (min/max)	Overall
11, 71, 72, 73	18.0 hrs	6.0 hrs	1.0 hrs / 8.0 hrs	24.0 hrs

Table 11 - Charge timeouts for algorithms 11, 71, 72, and 73.

Algorithms 42, 43, and 87: Pulse Finish Restart Charging for AGM Batteries

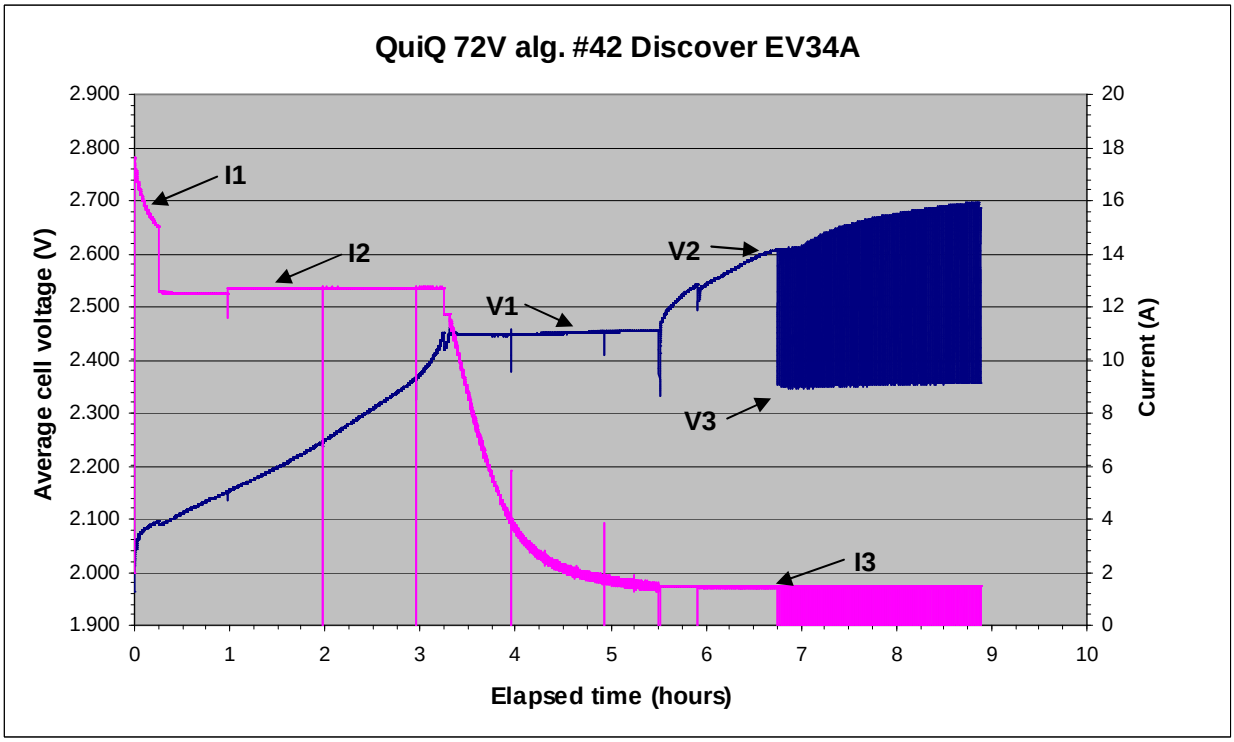

Figure 6 - Sample charge cycle for algorithm 42.

These algorithms use a *pulse* termination criterion. As a safety precaution during the *Finish* phase, if the average cell voltage, or volts per cell (Vpc), exceeds *V2* and the charger output has been on more than 30 seconds the output is shut off until the Vpc falls to *V3*. The *Finish* phase then resumes and this "pulsing" continues until the target overcharge is reached.

Charge Setpoints

Algorithm	I1	I2	V1	I3	Overcharge	V2	V3
42 75-150Ah	Max - Pulse	Max	2.41 Vpc	1.5 A	110%	2.60 Vpc	2.35 Vpc
43 200-400Ah	Max - Pulse	Max	2.41 Vpc	4.0 A*	110%	2.60 Vpc	2.35 Vpc
87 40-80Ah	Max - Pulse	Max	2.43 Vpc	1.0 A	104%	2.55 Vpc	2.35 Vpc

Table 12 - Charge timeouts for algorithms 42,43, and 87.

Charge Timeouts

Algorithm	Bulk	Absorption	Finish (min/max)	Overall
42	18.0 hrs or 150Ah	4.0 hrs	6.0 hrs	24.0 hrs
43	18.0 hrs	5.0 hrs	6.0 hrs	24.0 hrs
87**	8.0 hrs	6.0 hrs	4.0 hrs	24.0 hrs

Table 13 - Charge timeouts for algorithms 42,43, and 87.

*** Algorithm #43 raises finish current to 8.0A if battery voltage does not rise above 2.50Vpc in the first 15 minutes of *Finish* phase. This shortens charging completion time on large batteries.**

**** Algorithm #87 does not have a Maintenance Mode**

Algorithms 6, 12, 26, 51, and 52: Temperature Compensated Charging for Gel Batteries

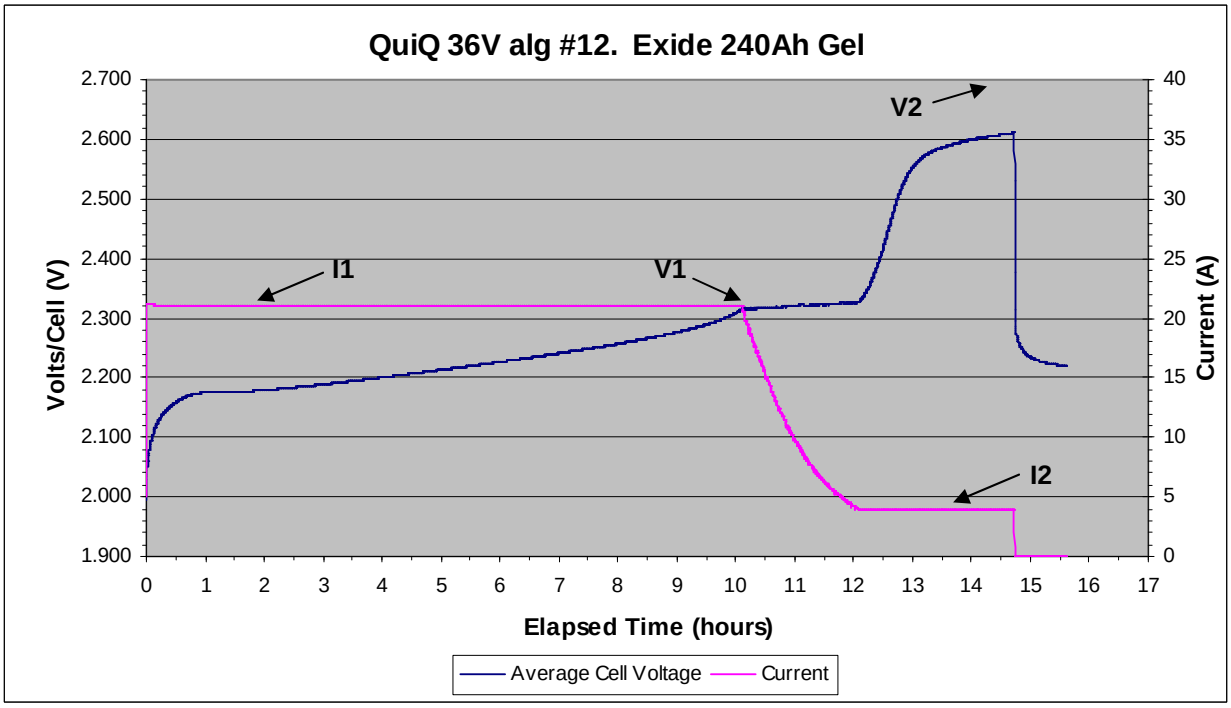

Figure 7 - Sample charge cycle for algorithm 12.

Algorithms 6 and 26 terminate at 1 hour, 2 hour, or 4 hour of *Finish* phase depending on the amount of charge returned in the *Bulk* and *Absorption* phases. Algorithms 12, 51, and 52 terminate when the target overcharge has been met. They all differ from Algorithms 1, 2, 4 and 5 in that there is no pulse phase at the beginning of charge. As a safety precaution during the *Finish* phase, if the battery voltage ever exceeds *V2* the charge cycle is terminated.

Charge Setpoints

Algorithm	I1	V1	I2	Overcharge	V2
6	Max	2.33 Vpc	1.75 A	1h if < 26Ah returned, 4h if >52Ah returned, else 2h	2.80 Vpc
26	Max	2.33 Vpc	4.0 A	1h if < 48Ah returned, 4h if >95Ah returned, else 2h	2.80 Vpc
12	Max	2.35 Vpc	4.0 A	104.5%	2.65 Vpc
51	Max	2.35 Vpc	3.0 A	104.5%	2.65 Vpc
52	Max	2.35 Vpc	2.0 A	104.5%	2.65 Vpc

Table 14 - Charge timeouts for algorithms 6, 12, 26, 51, and 52.

Charge Timeouts

Algorithm	Bulk	Absorption	Finish (min/max)	Overall
6	12.0 hrs	6.0 hrs	1.0 hrs /4.0 hrs	22.0 hrs
26	22.5 hrs	6.0 hrs	1.0 hrs /4.0 hrs	32.5 hrs
12, 51, 52	18.0 hrs	6.0 hrs	4.0 hrs	28.0 hrs

Table 15 - Charge timeouts for algorithms 6, 12, 26, 51, and 52.

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