Countries:	CANADA, UNITED STATES	**Document ID:**	IK0800510
Availability:	ISIS	**Revision:**	2
Major System:	ELECTRICAL SYSTEM	**Created:**	2/23/2015
Current Language:	English	**Last Modified:**	5/13/2015
Other Languages:	NONE	**Author:**	Chris Moody
Viewed:	257		

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Title: Cooper Bussmann Inverter Information/Diagnostics

Applies To: ProStar/LoneStar with 0008XDM,0008XDN

Change Log

4/29/15 - Initial Release
5/4/15 - Change Title to reflect name on Inverter label

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Introduction

International ProStar and LoneStar vehicles use the 1800W inverter with AGM batteries.

The Cooper Bussmann Inverter is designed to create either 1kW / 1.8kW of pure sine wave 115VAC 60Hz power from a 12V battery source. The units low Total Harmonic Distortion (<2.5% typical) can power sophisticated electronics that may not work with modified sine wave inverters. Unit also has high surge capability to power up hard to start loads like power tools, refrigerators or pumps.

- The Cooper Bussmann Inverter is protected against most abnormal conditions found in the automotive environment.
- The unit has a three setting under voltage alarm and shut down that prevents the batteries from becoming depleted.
- A warning alarm will sound when the maximum power output is being reached. An alarm will also sound if unit is overheating. If any of these conditions are not corrected, the unit will turn off safely to protect itself.
- Some models include a three stage temperature compensated battery charger that maximizes the life of the batteries. It can be configured for AGM, flooded or Gel lead acid batteries.

Cooper Bussmann inverters include a Shore Power bypass feature. When AC power (Shore Power) is detected at the AC input, the unit powers all accessories from this available power source. If the inverter automatically detects that AC input is removed, it becomes an independent AC supply. Inverter input current could be as high as 100A in the 1KW unit and 200A in the 1.8KW unit. Special care has to go into evaluating the proper sizing of batteries, wire gauge and length.

- The inverter's logic is powered by the 12V input battery. The unit current draw when power is off is typically less than 2mA.
- When the inverter is turned on with no load is connected to its output it will typically draw less than 0.5A.
- Operation efficiency is input voltage, load and ambient temperature dependent, but it is typically 90%.
- The Cooper Bussmann inverter will not withstand reverse polarity. Permanent damage will occur and is not covered by warranty.

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Configuration Guide

This section describes inverter operation, configuration and the meaning of error codes.

Setting battery types on main unit

The inverter can operate from and recharge several different types of lead-acid batteries. It is important to make sure the battery type is configured on the unit for optimum charging process before installing batteries. See Table 2.

Customizing display, alarm and charging current settings

The display panel is capable of adjusting the following:

- What is presently displayed on the screen
- Modify the charging current

Table 1

Battery type setting	Charge voltage VDC (tolerance ± 0.2Vdc)		
	Bulk	Absorption	Float
Fixed 13.5	13.5	13.5	13.5
Flooded	14.4	14.4	13.5
Gel	14.2	14.2	13.8
AGM	14.3	14.3	13.4

WARNING

Fire hazard – Programming the incorrect battery type may result in battery damage and a fire risk.

SELECT

To change display and read current inverter settings:

By default, the screen will display the input voltage in [Volts] and the "**Input Voltage (V)**" LED indicator will be illuminated.

1. Press the **SELECT** button once. Screen displays the DC input current in [Amperes] and the "**Input Current (A)**" LED indicator will illuminate.
2. Press the **SELECT** button once more. Screen displays the AC output power in [kilowatts] and the "**Output power (KW)**" LED indicator will illuminate.
3. Press the **SELECT** button once more (third time). Screen displays the inverter on/off mode: IN1 = On; IN0 = Off
4. Press the **SELECT** button once more (fourth time). Screen displays the battery charge current setting.
5. Press the **SELECT** button once more (fifth time). Screen displays the alarm setting: AL1 = Alarm on; AL0 = Alarm off.
6. Press the **SELECT** button once more (sixth time). Screen displays the Low Voltage Shut Down Level: Sdl = Low, Sdn = Mid, Sdh = High.
7. Press the **SELECT** button once more (seventh time). Screen displays the battery type for charging: Fl = Fixed; FLo = Flooded; gEL = Gel, Ag = AGM

To adjust alarm on/off [AL0, AL1] setting:

By default, the alarm is **ON**.

To change the alarm on/off setting:

1. Press and hold the **green power button** for approximately 5 seconds. The inverter will beep and the display will flash "Cur." Release the **green power button**.
2. Press **green power button** two times until "AL" is displayed.
3. Press **SELECT** button to toggle between the two alarm on/off settings:
   - "**AL0**" – this indicates the alarm is **OFF**
   - "**AL1**" – this indicates the alarm is **ON**
4. To choose a new setting, stop at the desired value, press and hold the select button for five seconds to memorize the setting.
5. Confirm the new setting by not touching the inverter for approximately 5 seconds to return to inverter setting display mode. Press **SELECT** button multiple times to confirm new setting(s).

To adjust low voltage shutdown [SdL, Sdn, SdH] setting:

By default, the low voltage shutdown setting is **Sdn, Mid**.

To change the low voltage shutdown setting:

1. Press and hold the **green power button** for approximately 5 seconds. The inverter will beep and the display will flash "Cur." Release the **green power button**.
2. Press g**reen power button** three times until "Sd" is displayed.
3. Press **SELECT** button to toggle between the three voltage shutdown settings:
   - "**SdL**" – this indicates the Low setting of 10.5V ± 0.3V
   - "**Sdn**" – this indicates the Mid setting of 11.8V ± 0.3V
   - "**SdH**" – this indicates the High setting of 12.2V ± 0.3V
4. To choose a new setting, stop at the desired value, press and hold the **SELECT** button for five seconds to memorize the setting.
5. Confirm the new setting by not touching the inverter for approximately 5 seconds to return to inverter setting display mode. Press **SELECT** button multiple times to confirm new setting(s).

To adjust battery type [Fl, FLo, gEL, Ag] setting:

By default, the battery type is **Fl, Fixed**.

To change the battery type setting:

1. Press and hold the **green power button** for approximately 5 seconds. The inverter will beep and the display will flash "Cur." Release the **green power button**.
2. Press **green power button** four times until "bAe" is displayed.
3. Press **SELECT** button to toggle between the four battery type settings:
   - "**Fl**" – this indicates Fixed setting.
   - "**FLo**" – this indicates Flooded battery setting.
   - "**gEL**" – this indicates Gel battery setting.
   - "**Ag**" – this indicates AGM battery setting.
4. To choose a new setting, stop at the desired value, press and hold the **SELECT** button for five seconds to memorize the setting.
5. Confirm the new setting by not touching the inverter for approximately 5 seconds to return to inverter setting display mode. Press **SELECT** button multiple times to confirm new setting(s).

To reset factory default settings:

By default, the inverter settings are **max charge current**, **IN1**, **AL1**, **Sdn**, **FI**

To reset these values:

1. Press and hold the **green power button** for approximately 5 seconds. The inverter will beep and the display will flash “Cur.” Release the **green power button**.
2. Press **green power button** five times until “**dEF**” is displayed.
3. Press and hold the **SELECT** button for five seconds to memorize the setting.
4. Confirm the new setting by not touching the inverter for approximately 5 seconds to return to inverter setting display mode. Press **SELECT** button multiple times to confirm new setting(s).

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Service Parts Information

Kit Description	Part Number	Qty	Notes
CABLE,ASM, INVERTER REMOTE SW	3757368C1	1	
CONTROL,ELECTRONIC , INVERTER	4041649C1	1	
RECTIFIER , INVERTER ASSEMBLY	6118866C91	1	

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Fault Codes and Troubleshooting

Inverter Section

Table 3	
Unit start up voltage (Lo setting):	> 10.5 ± 0.3 VDC and < 16.0 ± 0.3 VDC
Unit start up voltage (Mid setting):	> 11.8 ± 0.3 VDC and < 16.0 ± 0.3 VDC
Unit start up voltage (High setting):	> 12.2 ± 0.3 VDC and < 16.0 ± 0.3 VDC

DC Input Warning and Shutdown

Condition	UVSD setting	Setting ± 0.3Vdc	Display	Audible alarm	Comment
Over voltage instant shutdown	Lo, mid or hi	16.0	E02	Beep @ 1 Hz	Note 1
Over voltage recovery	Lo, mid or hi	15.5	--	--	Note 2
Under voltage instant shutdown	Lo, mid or hi	10.0	--	--	Note 3
Under voltage shutdown	Lo	10.5	E01	Beep @ 1 Hz	Note 4
Under voltage warning	Lo	11.0	E05	Beep @ 0.33 Hz	--
Under voltage recovery	Lo	12.0	--	--	--
Under voltage shutdown	Mid	11.8	E01	Beep @ 1 Hz	Note 4
Under voltage warning	Mid	12.1	E05	Beep @ 0.33 Hz	--
Under voltage recovery	Mid	12.6	--	--	--
Under voltage shutdown	Hi	12.2	E01	Beep @ 1 Hz	Note 5
Under voltage warning	Hi	12.2	E05	Beep @ 0.33 Hz	--
Under voltage recovery	Hi	13.0	--	--	--

NOTE:

1. Unit will shut down instantly and restart automatically if voltage returns to less than 15.5V within 30 seconds
2. If DC voltage is not less than 15.5V within 30 seconds, unit will require manual reset by power button
3. Unit will shut off instantly if DC voltage drops below 10V regardless of settings
4. Unit will shut off if DC voltage is below shutdown for 10 seconds
5. Unit will shut off if DC voltage is below shutdown for value for 3 minutes

AC output short circuit protection

A short circuit may be applied to the AC output continuously during inverter mode without damage to any components. Unit will shut down within 10 seconds, and display will indicate ‘E03’ with the buzzer beeping @ 1 Hz.

NOTE:

Manual reset is required to restart Inverter after AC Overload or Short Circuit shutdown. System will automatically reset AC Overload or Short Circuit shutdown error when utility is available. The supplemental protector or the branch protection specified in the Installation Guide should be open under bypass short circuit output condition.

Incorrect connection protection

Inverter DC input protection

- **AC input and AC output:** AC Input Line and Neutral reverse connection cannot be detected. Input and output ac terminals are labeled and unit should be installed by a professional installer.
- **Charger DC output protection:** Reverse polarity on DC terminal will open the CD input fuses in the Cooper Bussman Inverter.

This damage is not covered under warranty.

AC output protection

External AC source applied to the inverter AC output may damage the inverter. This damage is not covered by warranty.

Troubleshooting

The following Fault codes are provided on digital display when system Fault/Warning occurs:

Fault Codes - Displayed in LCD	
E01	DC Input Under-Voltage Shutdown. Unit is detecting an input DC voltage which is too low and it is shutting down. This fault can be caused by a discharged or undersized battery. Incorrect DC wiring length and gauge or fault DC connection can also cause this fault.
E02	DC Input Over-Voltage Shutdown. This fault could be due to a problem in the vehicle charging system. Unit will resume normal operation when voltage returns to the allowed input voltage range.
E03	Inverter Output Overload (or Short Circuit) Shutdown. Unit is being severely overloaded. Reduce the load. If this fault occurs in shore power mode the unit must be reset. To reset, remove AC loads and turn inverter power off and on.
E04	Inverter Over-Temperature Shutdown. Unit is shutting down to protect itself from thermal damage. Place the unit in a location with lower ambient temperature or improve air flow around the unit.
E05	DC Input Under-Voltage Warning. Unit is detecting an input DC voltage which is too low and it is warning the user that it will shut down within 10 seconds. This fault can be caused by a discharged or undersized battery. Incorrect DC wiring length and gauge can also cause this fault.
E06	Inverter Output Overload Warning. Inverter is detecting an overload and it is warning that it is going to shut down within 10 seconds. Reduce load and inverter will keep operating normally.
E07	Inverter Over-Temperature Warning. Inverter is approaching its maximum operating temperature and it will shut down within 10 seconds. Reduce load or/and move the inverter to a location with lower ambient temperature or better air flow.
E08	Not used
E09	Not used
E10	Charger Output Over Voltage Shutdown. Battery charger has detected a battery voltage above normal operating range. Vehicle charging system may be damaged.
E11	Battery not accepting charge. Inverter is trying to charge the battery, but battery voltage is not increasing over time. Battery may be damaged
E12	Transfer Relay Over-Temperature Shutdown. Relay that switches inverter to shore power mode is running at an unusually high temperature and unit it is shutting down to protect itself. This could be due to an overload condition in shore power mode. Reduce the load and unit will return to normal operation

AC input surge protection

- 175 J MOV is connected across the Line and Neutral of AC Input

Charger DC output over voltage shutdown

- Battery over voltage protection: 16.0 ± 0.5Vdc (Error code: E10)
- Audio Alarm: Beep @ 1 Hz and AC charger is latched off
- Bypass mode is available
- To reset error code, remove AC Input and turn unit off and on

Dead battery charging

Battery voltage must meet the following conditions or Error code E11 will display:

- Initial battery voltage must be 10V or higher for charge to commence
- In event battery voltage drops below 10V after charge is initiated (added load) maximum time for battery voltage to rise above 10V in Bulk charge: 15 minutes
- Audio alarm: Beep @ 1 Hz and AC charger is latched off following 15 minute delay
- Bypass mode is available
- To reset error code, remove AC Input and cycle unit off and on until reset

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Fault Code Troubleshooting

Inverter Inoperative

Step	Symptom Verification	Decision
#1	**Attempt to power on inverter from the display panel** **Does inverter turn on?**	**Yes: Restore truck to operating condition and contact supervisor. Discuss conditions when symptom occurred with customer.**
		No: Go to Step 2

Step	Power To Inverter	Decision
#2	**Check for minimum of 12v at inverter.**	**Yes: Got to step 3**

	is 12v or more present at inverter	**No: Determine cause of missing 12v, repair and retest**

Step	Ground to Inverter	Decision
#3	**Check for ground to inverter.** **Is ground present at inverter?**	**Yes: Got to Step 4**
		No: Determine cause of missing ground to inverter, repair fault, and retest.

Step	Check Display Panel Connections	Decision
#4	**Remove display panel and inspect cable connections for damaged pins, chaffing or other issues. The cable is housed within the sleeper harness. Check for rubbing, sharp bends in the cable or sharp edges.** **Are any issues identified with cable or connections?**	**Yes: make repairs as necessary. The cable and/or display can be replaced individually. Retest operation after repairs.**
		No: Replace inverter. Retest for proper system operation

Fault Code E01/E05/E11

Step	Inspect Battery Cables and Connections	Decision
#1	1. Inspect Battery Cable Connections per IK0800482 2. Inspect Battery Cable Connections at the inverter Were cables free of corrosion/issues?	**Yes:** Go to Step 2
		No: Perform all necessary repairs and retest for symptom

Step	Battery Test	Decision
#2	Perform Battery Test (IK0800482) Did Batteries Pass testing	**Yes:** Go to step 3
		No: Perform all necessary repairs and retest for symptom

Step	Voltage Drop Test Positive Cable	Decision
#3	Check voltage drop between batter to inverter cables Was voltage drop greater than .3v?	**Yes:** Replace positive cable
		No: Perform all necessary repairs and retest for symptom

Step	Voltage Drop Test Negative Cable	Decision
#4	**Check voltage drop between batter to inverter cables** **Was voltage drop greater than .3v?**	**Yes: Replace negative cable**
		No: Restore truck to operating condition and contact supervisor.

Inverter Turns on but is inoperative(Associated with code E03,E06)

Step	Symptom Verification	Decision
#1	Does inverter turn on and display show E03 plus an alarm sound?	**Yes:** Go to Step 2
		No: Interview driver for further information. Inquire about loads that might have been used at the time of concern.

Step	Check for load	Decision
#2	Are there loads plugged into Inverter that draw beyond the inverter specification of 1800watts? Unplug all loads and retest.	**Yes:** Replace inverter

	Does Inverter display continue to show E03?	**No:** The system was overloaded. Instruct customer on inverter requirements and to reduce loads to within inverter capability.(For capability specification, refer to introduction section of this document.)

Fault Code E02/E10

Step	Symptom Verification	Decision
#1	Does inverter turn on and display show E02 plus an alarm sound?	**Yes:** Refer to IK0800403 for checking the charging system. If issue still present Restore truck to operating condition and contact supervisor.
		No: Interview driver for further information. Inquire about loads that might have been used at the time of concern.

Fault Code E04/E07

Step	Symptom Verification	Decision
#1	Inverter over temp shut down Power on inverter, does display show E04 and sound an alarm	**Yes:** clear any obstructions from around the inverter and retest, if E04 is still displayed Go to step 2
		No: Interview driver for further information. Inquire about loads that might have been used at the time of concern.
Step	**Check fan operation**	**Decision**
#2	Operate inverter with a load, does cooling fan come on?	**Yes:** no repair at this time, release vehicle
		No: replace inverter

Fault Code E12-Transfer Relay Over-Temperature Shutdown

Step	Symptom Verification	Decision
#1	This troubleshooting will require an extension cord be plugged into side of truck to simulate shore-power mode. No special cord is required. Plug cord into shore power and operate inverter. Does display show E12?	**Yes:** Check for excessive loads plugged into inverter. Remove loads and retest
		No: The system was overloaded. Instruct customer on inverter requirements and to reduce loads to within inverter capability.(For capability specification, refer to introduction section of this document.)

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Operational Specifications

Table 4 - AC output overload protection and warning shutdown

Model	Condition	Power (W)			Display	Audible alarm
		< 11.4Vdc	11.4 < 11.8Vdc	>11.8Vdc		
12-110-1000-xx	Warning (± 100W)	950	1000	1100	E06	Beep @ 0.33 Hz
	Shutdown (± 100W)	1050	1100	1200	E03	Beep @ 1 Hz
12-110-1800-xx	Warning (± 100W)	1750	1850	2000	E06	Beep @ 0.33 Hz
	Shutdown (± 100W)	1850	1950	2100	E03	Beep @ 1 Hz

Table 6 - Over temperature protection

Location	Condition	
Charger transformer	> 95ºC	Max Charge current reduced to half of full load
	> 100ºC	Max Charge current reduced to 0A
AC transfer relay	> 70ºC	System shutdown (no auto-reset)
Max charge current resumes normal level when Charger Transformer sensor temperature drops below 90ºC		

Table 7 - Over temperature protection faults						
Location	Warning (ºC)		Error code / audio alarm	Shutdown (ºC)		Error code / audio alarm
	On	Off		On	Off	
Rectifier diode	> 90ºC	< 88ºC	E07 / beep @ 0.33 Hz	> 95ºC	< 80ºC	E04 / beep @ 1 Hz
Extrusion	> 63ºC	< 60ºC		> 60ºC	< 56ºC	
Over temperature shutdown of these sensors is auto reset. Sensor temperature tolerance is ± 5ºC						

Table 8 - Input Voltages			
	Low	Mid	High
Nominal DC input	12.5 Vdc	13.0 Vdc	13.0 Vdc
Input voltage operating range	10.5 - 16.0 Vdc	11.8 - 16.0 Vdc	12.2 - 16.0 Vdc
No load input current (inverter on)	< 0.9 Adc when input voltage is ≥ 11.5 Vdc		
	< 1.5 Adc when inputvoltage is < 11.5 Vdc		
No load input current (inverter off)	< 1.0 mA (inverter button off and to utility power connection)		
All DC voltage tolerances ± 0.3 Vdc			

Table 9 - AC Outputs		
	1000W	1800W
Continuous output power	1000W (8.3A)	1800W (15A)
Surge output power (5 seconds)	1200W	2000W
Surge output power	2000W (200 ms)	3600W (300ms)
Operating temperature range	0ºC to +50ºC	0ºC to +50ºC
Storage temperature range	-40ºC to 85ºC	-40ºC to 85ºC
THD (Resistave load)	5% max, 2.5% typical	5% max, 2.5% typical
Ouput power rated at 25ºC, continuous power de-rated lineraly to 70% at 50ºC. After extreme hot or cold storage, unit requires on hour of 0ºC to 25ºC storage before operating.		

Table 10 - AC Transfer	
AC input transfer from	95 Vac
AC input recovery from inverter to utility	100 Vac
Utility to inverter and inverter to utility hysteresis	5 Vac minimum
Max AC output by-pass current	20 Arms
AC transfer time - utility to inverter	< 50ms
Time delay on transfer from inverter to utility	20s ± 2s
Voltages ± 5V	

Table 11 - Battery Charger		
AC input operating range	95 - 135 Vac	
AC input range with full power	105 - 135 Vac	
AC input current with no load	< 0.50 Arms	
Input current full load	< 6 Arms (12-110-1000-B2)	11.5 Arms (12-110-1x00-B4)
AC input frequency	60 Hz ± 1 Hz	
Operating temperature range	0ºC to +50ºC (allow for 1.5 Adc charge current reduction above 40ºC)	

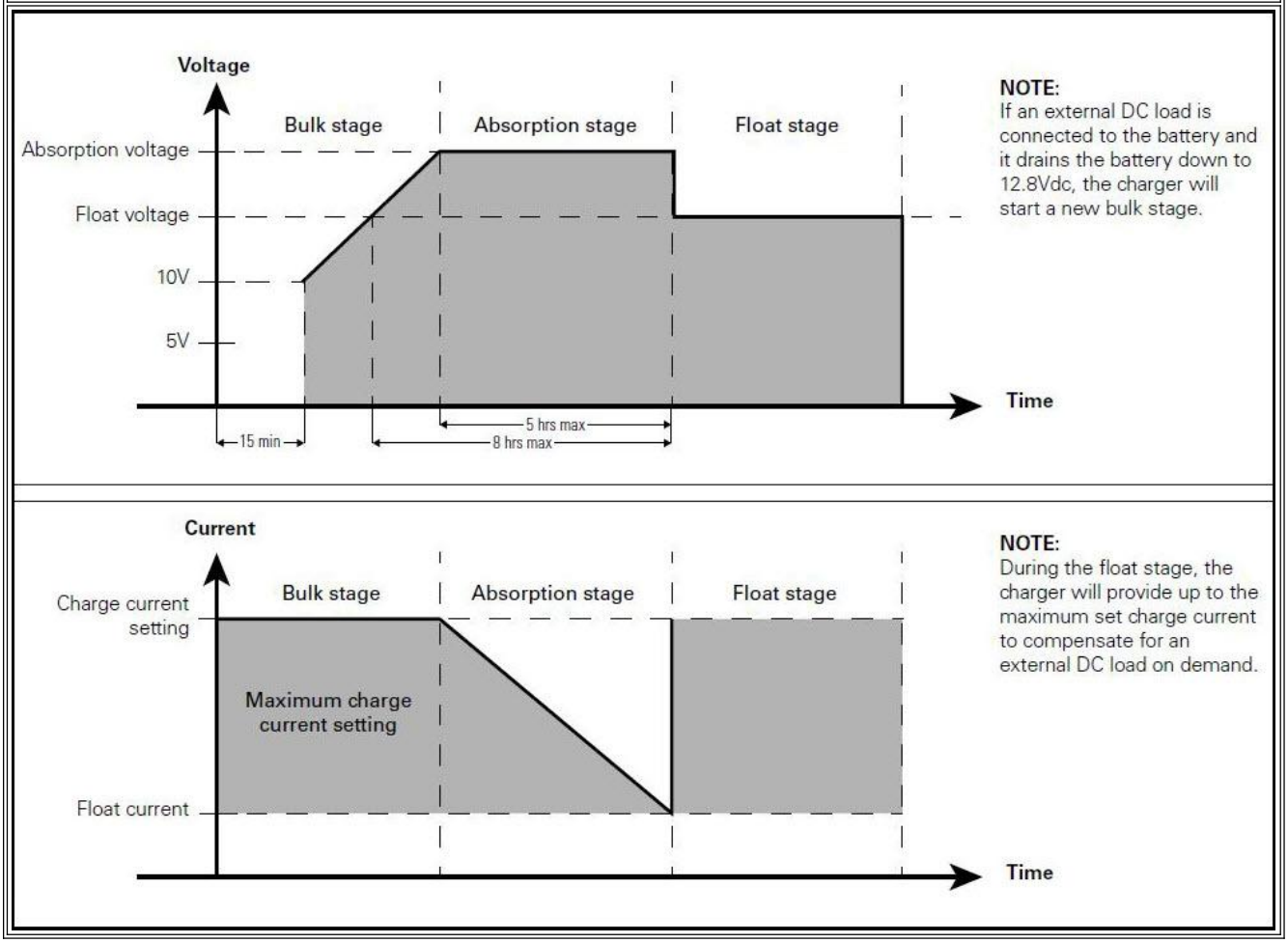
Table 12 - DC Output Voltage			
Battery type setting	O/P voltage VDC (tolerance ± 0.2 Vdc)		
	Bulk	Absoption	Float
Fixed 13.5	13.5	13.5	13.5
Flooded	14.4	14.4	13.5
Gel	14.2	14.2	13.8
AGM	14.3	14.3	13.4

Table 13 - DC Output Current	

Model	Maximum DC output current (Adc)			
	Setting1	Setting2	Setting3	Setting4
12-110-1000-B2	2 ± 0.5	5 ± 0.5	10 ± 1	20 ± 2
12-110-1000-B4	2 ± 0.5	10 ± 1	20 ± 2	40 ± 4
12-110-1800-B4				

Table 14 - Fan On/Off Setting		
Parameter	Fan on	Fan off
Load	> 500W	< 20W
Extrusion temperature	> 60ºC	< 55ºC
Rectifier diode	> 70ºC	< 60ºC

Figure 1 - Charging Algorithm



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Warranty Information

Warranty Claim Coding:

Group:	08960 - Miscellaneous (Electrical)
Noun:	506 - DC To AC Inverter

Standard Repair Time(s):

Description	Chassis	Engine	SRT
Replace Inverter - R08-8506A	ProStar	N13/ISX	0.6
Replace Inverter - S08-8506A	LoneStar	N13/ISX	0.6
Overlay Cable-R08-8506A-20	ProStar	N13/ISX	0.7
Overlay Cable-S08-8506A-20	LoneStar	N13/ISX	0.7

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