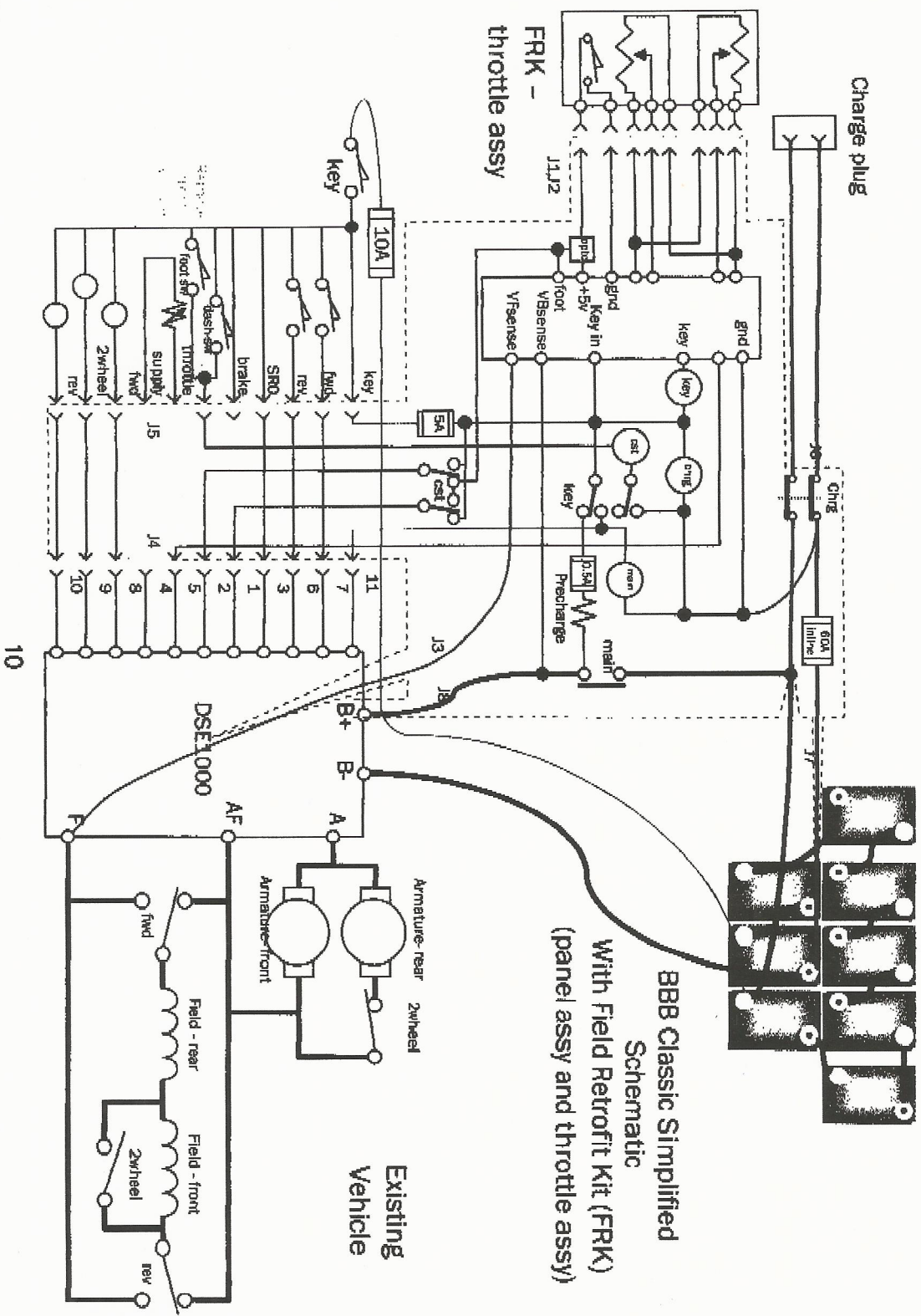


Classic Buggy - Field Retrofit Kit



BBB Classic Simplified
Schematic
With Field Retrofit Kit (FRK)
(panel assy and throttle assy)

575 Kumpf Drive
Waterloo, Ontario
N2V 1K3

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Phone: (519) 342-2507
Fax: (519) 342-2508
www.navitastechnologies.com

6 Vehicle Troubleshooting Guide

Visible through the hole in the top of the FRK are two LED's – red and green.

Red	Grn	Condition
Off	On	System operates normally
flashing	On	Condition on startup which prevents power from being applied
On	Flashing	Vehicle will not operate. Number of green flashes indicates fault.

The detailed meanings are as follows:

Red	Grn	Condition	Action
Off	Off	System is off	Check fuses on FRK. Check that key switch is providing power.
Off	On	Operating Normally	None. Vehicle should operate normal – main contactor is on, key power is provided to DSE1000
1 Flash	On	After power is turned on, waiting for the foot switch on the pedal to go "open" (foot off pedal). After 2 minutes, the system will fault out and go to Red=on, Green=4 flashes.	Check the foot switch wiring. Check that nothing is stopping the pedal from coming up.
2 Flashes	On	After power is turned on, waiting for the voltage on the DSE1000 B+ terminal to go higher than 38 volts. This should take no more than a few seconds. If it takes more than 10 seconds, the system will fault out and go to Red=on, Green =5 flashes.	Check the fuses on the FRK. Check the voltage between the B+ and B-bars on the DSE1000. If it is zero, either the DSE1000 is faulty or there is a short in the system.
On	1 Flash	The "F" bar has a low voltage when the foot switch is open. Usually indicates a faulty DSE1000 or a motor wiring issue	Refer to the DSE1000 manual for further troubleshooting.
On	2 Flashes	The foot switch (accelerator pedal) has been off for 2 minutes.	Turn the vehicle off and then on again. If this occurs even when the pedal is pressed, then check the wiring from the pedal.
On	3 Flashes	Pedal Fault. The pedal has 2 independent sensors, and they are not consistent.	Check the pedal wiring. The output voltages from the pedals should sum to 5.0 volts.
On	4 Flashes	The foot switch was closed for 2 minutes after the key was turned on.	Check the foot switch wiring. Check that nothing is stopping the pedal from coming up.
On	5 Flashes	The DSE1000 did not charge up.	Check the fuses on the FRK. Check voltage between the B+ and B-bars. If it is zero, either the DSE1000 is faulty or there is a system short.
On	6 Flashes	Pedal Fault. The pedal sensor showed more than ½ way down, but the pedal switch still showed open.	Check the foot switch wiring.

7 FMEA Summary

To quote:

FMEA is a methodology to analyze and discover:

- (1) all potential failure modes of a system,
- (2) the effects these failures have on the system and
- (3) how to correct and or mitigate the failures or effects on the system.

The FMEA seeks to rank the effects, occurrence and ability to detect each of the failures. For our purposes:

- *Effect* is a ranking of 1 (no hazard) to 10 (serious hazard), which considers only hazards, not inconvenience. Thus, a failure which leads to an inoperable vehicle has an effect of 1, though this may be very inconvenient to the user.
- *Occurrence* is a ranking of 1 (rare) to 10 (common among failures). This is a relative ranking, and does not translate to a probability that this failure will occur. For our purposes, wires falling off are likely (6) and shorting to the "right" terminal to cause the fault are less likely (3).
- *Detection* ranks the ability of planned tests and inspections to remove defects or detect failure modes in time. It is a ranking from 1 (quickly, effectively) to 10 (we can't detect or do something about it) and is really about *escaping detection*. For our purposes, they are mostly 1 (we deal with it effectively) or 10 (we don't know it occurs).

From these ranks, a *risk priority number* (RPN) is calculated as follows:

$$RPN = Effect \times Occurrence \times Detection$$

Note that RPN is also a *ranking* and does indicate that one failure is better or worse than another, but not by how much.

Finally, it should be said that these rankings require judgments and different people will tend to have different rankings. Because the outcome is a ranking, the FMEA does not tend to be sensitive to minor differences of opinion.

In the case of the Classic Buggy FRK, it is helpful to compare the FMEA with and without the FRK. One way to state the purpose of the FRK is to lower the rankings of the high ranking failures in the buggy.

To help in the presentation of the table, any RPN ranking over 150 has a red background.

7.1 FMEA with FRK

#	Name	Failure Mode	Effect	S	Cause	O	Controls with FRK	D	RPN
1	Pedal	Pedal imbalance	No vehicle power	1	most likely loss of wire, or sensor failure, moisture ingress	6	FRK monitors both pedal sensors. Key relay only remains closed while they are remain in balance.	1	6
2	Pedal	Foot switch stuck on	No vehicle power	2	Wire shorted to +v5, sensor failure. If wire shorts to +48, it will blow the opto-isolator and be stuck off	3	Check that foot switch turns off before power is applied. During operation, make sure that pedal input is < 30% depressed when foot switch is off	1	6
3	Pedal	Foot switch stuck off	No vehicle power	1	wire falls off, sensor failure	6	Vehicle will not operate with foot switch off	10	60
4	Dash coast/brake switch	Stuck off (in brake)	Loss of coast feature	2	wire falls off, switch failure	6	None	10	120
5	Dash coast/brake switch	Stuck on (in coast)	Loss of brake feature. Possible unexpected operation for driver	4	wire shorted, failed switch	2	None. Though information from the field indicates this feature is not used very much. Therefore occurrence is low	10	80
6	4Wheel drive failure	Stuck in one mode or other	wrong mode selected	1	wire falls off, shorts, switch failure	6	None	10	60
7	F/R selector	Stuck in 1 direction	can only drive in 1 direction	1	switch failure, wire short	3	None	10	30
8	F/R selector	Stuck in Neutral	No motor power	1	wire falls off, switch failure	6	None	10	60
9	key switch	left on	vehicle will be disabled after 2 minutes, and battery will drain very slowly and cannot be charged	2	operator error	10	Monitor foot switch for 2 minutes of inactivity	1	20
10	key switch	stuck on	vehicle will be disabled after 2 minutes, and battery will drain very slowly and cannot be charged	2	switch failure, wire short	3	Monitor foot switch for 2 minutes of inactivity	1	6
11	key switch	stuck off	no vehicle power	1	wire falls off, switch failure	6	None	10	60
12	FRK Main Contactor	Stuck off	No power to motors	1	wire falls off, fault contactor	6	No power can go to motors	1	6

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#	Name	Failure Mode	Effect	S	Cause	O	Controls with FRK	D	RPN
13	FRK Main Contactor	Stuck on	No effect if there is no other failure	1	contact tips welded	3	None	10	30
14	FRK Main Contactor	Stuck on & DSE1000 or wiring shorted	Runaway	10	contact tips welded and controller failed.	1	None, though this is extremely unlikely. In the event of a downstream short, the main contactor will never be closed, and hence this situation will not occur. This can occur if the main contactor has been failed for some time ... since there is no detection for it.	10	100
15	FRK Main Contactor	Stuck on and power surge during charging	Not sure, but in conjunction with another failure, could include fire	10	contact tips welded, while charging, failure of another system	2	None, though this is extremely unlikely.	10	
16	DSE1000	Stuck on - at powerup	No vehicle power. Fuse will blow after 10 seconds of key on and the vehicle will no longer operate	1	internal failure	4	F bar voltage detection will fail, and key/main contactor will remain open	1	4
17	DSE1000	Stuck on - while driving	Unintended acceleration	6	internal failure	3	None. Natural reaction is take take foot off accelerator, so then "Stuck on -foot off pedal condition applies)	10	
18	DSE1000	Stuck on - foot off pedal	No vehicle power	1	internal failure	3	F bar voltage detection will fail (takes 1/2 second), and key/main contactor will open	4	12
19	DSE1000	Open	No motor power	1	internal failure	6	None, but no operation	10	60
20	DSE1000	Shorted B+ to B-	No vehicle power	1	internal failure	4	Precharge will fail and key/main contactor will not close	1	4
21	FRK - coast relay	stuck in brake	Loss of coast feature	2	relay failure	1	None	10	20
22	FRK - coast relay	stuck in coast	Loss of brake feature. Possible unexpected operation for driver	4	relay failure	1	None. Though information from the field indicates this feature is not used very much. Therefore occurrence is low	10	40
23	FRK - key relay	stuck off	No vehicle power	1	relay failure	1	None	10	30



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#	Name	Failure Mode	Effect	S	Cause	O	Controls with FRK	D	RPN
24	FRK - key relay	stuck on	Nothing by itself. Removes the protection provided by the panel	6	relay failure	1	None	10	60
25	FRK - charge relay	one phase stuck closed	Likely no impact	1	relay failure	1	None	10	10
26	FRK - charge relay	both phases stuck closed	Not sure, but in conjunction with another failure, could include fire	10	relay failure	D.1	None	10	10
27	FRK - charge relay	one phase stuck open	will not charge	1	relay failure	1	None	10	10
28	FRK - charge relay	both phases stuck open	will not charge	1	relay failure	1	None	10	10
29	FRK controller failure	key relay stuck on	Nothing by itself. Removes the protection provided by the panel	6	FET failure (shorted)	1	None	10	60
30	FRK controller failure	key relay stuck off	No vehicle power	1	FET failure (open)	1	None	10	10

in conclusion, with a welded main contactor, the vehicle cannot tolerate a second serious failure. It is still better than the vehicle without the FRK because of the improved accelerator pedal.

7.2 FMEA without FRK

#	Name	Failure Mode	Effect	S	Cause	O	Controls without FRK	D	RPN
1	Pedal	Pedal imbalance	Anything from no motor power to a runaway vehicle	10	water in pedal, loose wire, bypassed foot switch	10	None. Note that because of the previous pedal quality, this is much more likely to occur	10	
2	Pedal	Foot switch stuck on	Nothing by itself. With another failure can result in a runaway vehicle	5	sensor failure, shorted wire	5	None. Note that because of the previous pedal quality, this is much more likely to occur	10	



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#	Name	Failure Mode	Effect	S	Cause	O	Controls without FRK	D	RPN
3	Pedal	Foot switch stuck off	Either no effect (if coast), of vehicle won't drive. This makes it more likely that the operator will use the coast switch (vehicle runs), and hence more likely that fault 1 will occur	5	wire falls off, sensor failure	7	None. Note that because of the previous pedal quality, this is much more likely to occur.	10	
4	Dash coast/brake switch	Stuck off (in brake)	Loss of coast feature	2	wire falls off, switch failure	6	None	10	120
5	Dash coast/brake switch	Stuck on (in coast)	Loss of redundant shutdown.	5	wire shorted, failed switch	2	None. Though information from the field indicates this feature is not used very much. Therefore occurrence is low	10	100
6	4Wheel drive failure	Stuck in one mode or other	wrong mode selected	1	wire falls off, shorts, switch failure	6	None	10	60
7	F/R selector	Stuck in 1 direction	can only drive in 1 direction	1	switch failure, wire short	3	None	10	30
8	F/R selector	Stuck in Neutral	No motor power	1	wire falls off, switch failure	6	None	10	60
9	key switch	left on	potential runaway, if changing could result in fire	10		10	None	10	
10	key switch	stuck on	potential runaway, if changing could result in fire	3		10	None	10	
11	key switch	stuck off	no vehicle power	1	wire falls off, switch failure	6	None	10	60
16	DSE1000	Stuck on - at powerup	Runaway vehicle	10	internal failure	1	None	10	100
17	DSE1000	Stuck on - while driving	Runaway vehicle	10	internal failure	3	None	10	



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#	Name	Failure Mode	Effect	S	Cause	O	Controls without FRM	D	RPN
18	DSE1000	Stuck on - foot off pedal	Runaway vehicle	10	internal failure	3	None	10	
19	DSE1000	Open	No motor power	1	internal failure	6	None, but no operation	10	60
20	DSE1000	Shorted B+ to B-	Short - blow main fuse, or if not fused properly, possible fire	10	internal failure	4	None	10	