



Controls Specifications (CS)

M17

Controls Group

Revision Number: A

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Revision History

Change #	Description of Change	Source of Change	Date	Author
A	Initial starting document		4/29/2015	CS

Table of Contents

Overview.....	5
Input Peripherals	6
Down Pressure.....	7
Scrub Actuator Control	7
Scrub.....	8
Main Scrub Motors	8
Main Scrub Actuator	9
Side Scrub Motor	12
Water Pick-up	13
Water Pick-up Control	13
Water Pick-Up Vacuum.....	14
Squeegee Actuator	15
Solution Control.....	16
Main Water Valve	16
Detergent Pump	16
Side Valve.....	17
Side Pump	17
Extended Scrub Pump.....	18
Recovery AutoFill Valve	18
Solution AutoFill Valve.....	19
EcH2O	19
Sweep	20
Sweep Control	20
Main Sweep Head Brush Motors	21
Main Sweep Actuator	22
Side Sweep Head Brush Motors	23
Side Sweep Actuators	24
Dust Vac Motors	25
Filter Shaker Motor.....	26
Hopper Control.....	27
Hopper Control	27
Hopper Lift Pump.....	28
Hopper Roll Actuator	29
Propel	30
Curtis.....	30
APPENDIX A – Glossary	31

Table of Tables

Table 1: Hopper Input Operation Design Parameters	6
Table 2: Solution Input Operation Design Parameters	6
Table 3: Scrub Actuator Control Module Operation Design Parameters	7
Table 4: Main Scrub Motor Module Operation Design Parameters	8
Table 5: Main Scrub Motor Module Fault Design Parameters	8
Table 6: Main Scrub Actuator Operation Design Parameters	9
Table 7: Main Scrub Actuator Timeout Design Parameters	10
Table 8: Main Scrub Actuator Fault Design Parameters	11
Table 9: Side Scrub Motor Module Operation Design Parameters	12
Table 10: Side Scrub Motor Module Fault Design Parameters	12
Table 11: Sweep Control Operation Design Parameters	13
Table 12: Water Pick-Up Vacuum Module Operation Design Parameters	14
Table 13: Water Pick-Up Vacuum Module Fault Design Parameters	14
Table 14: Squeegee Actuator Module Operation Design Parameters	15
Table 15: Squeegee Actuator Module Fault Design Parameters	15
Table 16: Main Water Valve Module Fault Design Parameters	16
Table 17: Detergent Pump Module Operation Design Parameters	16
Table 18: Detergent Pump Module Fault Design Parameters	16
Table 19: Side Valve Module Fault Design Parameters	17
Table 20: Side Pump Module Operation Design Parameters	17
Table 21: Side Pump Module Fault Design Parameters	17
Table 22: Extended Scrub Pump Module Operation Design Parameters	18
Table 23: Extended Scrub Pump Module Fault Design Parameters	18
Table 24: Recovery AutoFill Valve Module Fault Design Parameters	18
Table 25: Solution AutoFill Valve Module Fault Design Parameters	19
Table 26: Sweep Control Operation Design Parameters	20
Table 27: Main Sweep Head Brush Motors Module Operation Design Parameters	21
Table 28: Main Sweep Head Brush Motors Fault Design Parameters	21
Table 29: Main Sweep Actuator Operation Design Parameters	22
Table 30: Main Sweep Actuator Fault Design Parameters	22
Table 31: Side Sweep Head Brush Motors Module Operation Design Parameters	23
Table 32: Side Sweep Head Brush Motors Fault Design Parameters	23
Table 33: Side Sweep Actuators Operation Design Parameters	24
Table 34: Side Sweep Actuators Fault Design Parameters	24
Table 35: Dust Vac Motors Module Operation Design Parameters	25
Table 36: Dust Vac Motors Fault Design Parameters	25
Table 37: Filter Shaker Motor Module Operation Design Parameters	26
Table 38: Filter Shaker Motor Fault Design Parameters	26
Table 39: Hopper Control Module Operation Design Parameters	27
Table 40: Hopper Lift Pump Motor Module Operation Design Parameters	28
Table 41: Hopper Lift Pump Motor Fault Design Parameters	28
Table 42: Hopper Roll Actuator Operation Design Parameters	29
Table 43: Hopper Roll Actuator Fault Design Parameters	29
Table 44: iDrive Module Operation Design Parameters	30

OVERVIEW

This section lays out many of the design specifics required to be compatible with the existing design. Many design parameters have been chosen and put in place with third party groups that require this design to follow these constraints.

The tables represent the default factory configuration. There may be special circumstances in which a specific machine may be configured to deviate from this specification.

INPUT PERIPHERALS

Table 1: Hopper Input Operation Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Hopper Lift	t _{HLIFT}	Debounce Time	-	50	-	msec
Hopper Lower	t _{HLOWER}	Debounce Time	-	50	-	msec
Hopper Roll Out	t _{HROUT}	Debounce Time	-	50	-	msec
Hopper Roll In	t _{HRIN}	Debounce Time	-	50	-	msec
Hopper Home	t _{HOME}	Debounce Time	-	2000	-	msec
Filter Shaker	t _{FLTSHKR}	Debounce Time	-	50	-	msec
Filter Clogged	t _{FLTCLGD}	Debounce Time	-	50	-	msec

Table 2: Solution Input Operation Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
SE Long	t _{SELONG}	Debounce Time	-	0	-	msec
SE Short	t _{SESHORT}	Debounce Time	-	0	-	msec
Recovery Tank Full	t _{RTFULL}	Debounce Time	-	5000	-	msec
Recovery Tank Half	t _{RTHALF}	Debounce Time	-	5000	-	msec
Sol Tank Empty	t _{SOLEEMPTY}	Debounce Time	-	5000	-	msec

DOWN PRESSURE

SCRUB ACTUATOR CONTROL

The Design Parameters for the Scrub Actuator Control module are shown in the table below:

Table 3: Scrub Actuator Control Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	A _{BAND}	Current Band Size	-	2	-	A
	A _{FLAT}	Flat Current Threshold	-	200	-	mA
	n _{SMPL}	Number of Current Samples	-	5	-	#
	t _{FLATUP}	Flat Step Size Up	-	-50	-	msec
	t _{FLATDN}	Flat Step Size Down	-	50	-	msec
	t _{UP}	Step Size Up	-	-25	1000	msec
	t _{DN}	Step Size Down	-	25	1000	msec

MAIN SCRUB MOTORS

The Design Parameters for the Main Scrub Motor modules are shown in the two tables below:

Table 4: Main Scrub Motor Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	S _{CTRG} T	Cylindrical Target Speed	-	1750	-	RPM
	S _{DTRG} T	Disk Target Speed	-	2520	-	RPM
	t _{TSK}	Task rate	-	50	-	msec
Soft Start	t _{SFTSTART}	Time Interval Configurable in 0.1s increments 0: Disabled	0	1	30	sec

Table 5: Main Scrub Motor Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Open Fault	A _{OPEN}	Open Fault Threshold	-	1	-	A
	t _{OPEN}	Open Fault Time	-	5	-	sec
Hardware Fault	t _{HW}	Open Fault Time	0	5	30	sec
Overtemp Fault	t _{OPEN}	Open Fault Time	-	3	-	msec
Over Voltage Fault	t _{SHORT}	Open Fault Time	-	5	-	sec
Motor Fault	A _{MTR}	Motor Fault Over Current Threshold	-	42	-	A
	S _{MTR}	Motor Fault Speed Threshold	-	500	-	RPM
	t _{MTR}	Motor Fault Time	-	15	-	sec

MAIN SCRUB ACTUATOR

The Design Parameters for the Main Scrub Actuator module are shown in the three tables below:

Table 6: Main Scrub Actuator Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{FAST}	Fast Speed Duty Cycle	-	95	-	%
	D _{NRML}	Normal Speed Duty Cycle	-	75	-	%
	D _{SLOW}	Slow Speed Duty Cycle	-	50	-	%
	D _{HUNT}	Hunt Speed Duty Cycle	-	30	-	%
	t _{TSK}	Task rate	-	25	-	msec
	V _{BATT}	No Battery Voltage Compensation	-	-	-	V

Table 7: Main Scrub Actuator Timeout Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
General	t_{TIMEOUT}	Default Timeout	-	16	-	sec
	t_{DPRF} (Disk)	Parked to Ready Fast Timeout	-	5	-	sec
	t_{DHNT} (Disk)	Hunt Time	0.5	60	-	sec
	t_{DLLT} (Disk)	Lower from Lost Timeout	-	30	-	sec
	t_{DLPF} (Disk)	Lowered to Parked Fast Timeout	-	1	-	sec
	t_{DLPN} (Disk)	Lowered to Parked Normal Timeout	-	1	-	sec
	t_{DLPS} (Disk)	Lowered to Parked Slow Timeout	-	8	-	sec
	t_{DRPF} (Disk)	Ready to Parked Fast Timeout	-	0.1	-	sec
	t_{DRPN} (Disk)	Ready to Parked Normal Timeout	-	0.2	-	sec
	t_{DRPS} (Disk)	Ready to Parked Slow Timeout	-	8	-	sec
	t_{DLTPS} (Disk)	Lost to Parked Slow Timeout	-	12	-	sec
	t_{DLR} (Disk)	Lowered to Ready Timeout	0.1	-	7	sec
	t_{DPRF} (Cyl)	Parked to Ready Fast Timeout	-	4.1	-	sec
	t_{DHNT} (Cyl)	Hunt Time	2.5	60	-	sec
	t_{DLLT} (Cyl)	Lower from Lost Timeout	-	0.1	-	sec
	t_{DLPF} (Cyl)	Lowered to Parked Fast Timeout	-	1	-	sec
	t_{DLPN} (Cyl)	Lowered to Parked Normal Timeout	-	2	-	sec
	t_{DLPS} (Cyl)	Lowered to Parked Slow Timeout	-	8	-	sec
	t_{DRPF} (Cyl)	Ready to Parked Fast Timeout	-	0.4	-	sec
	t_{DRPN} (Cyl)	Ready to Parked Normal Timeout	-	0.4	-	sec
	t_{DRPS} (Cyl)	Ready to Parked Slow Timeout	-	8	-	sec
	t_{DLTPS} (Cyl)	Lost to Parked Slow Timeout	-	12	-	sec
	t_{DLR} (Cyl)	Lowered to Ready Timeout	0.1	-	7.25	sec
	t_{MAN}	Manual Timeout	-	30	-	sec

Table 8: Main Scrub Actuator Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Stall Fault	A _{DSTALLF}	Disk Fast Stall Fault Threshold	-	8	-	A
	A _{DSTALLN}	Disk Normal Stall Fault Threshold	-	8	-	A
	A _{DSTALLS}	Disk Slow Stall Fault Threshold	-	8	-	A
	A _{DSTALLH}	Disk Hunt Stall Fault Threshold	-	8	-	A
	A _{CSTALLF}	Cyl Fast Stall Fault Threshold	-	10	-	A
	A _{CSTALLN}	Cyl Normal Stall Fault Threshold	-	10	-	A
	A _{CSTALLS}	Cyl Slow Stall Fault Threshold	-	10	-	A
	A _{CSTALLH}	Cyl Hunt Stall Fault Threshold	-	10	-	A
	t _{STALLF}	Fast Stall Fault Time	-	0.5	-	sec
	t _{STALLN}	Normal Stall Fault Time	-	0.5	-	sec
	t _{STALLS}	Slow Stall Fault Time	-	0.5	-	sec
	t _{STALLH}	Hunt Stall Fault Time	-	0.5	-	sec

SIDE SCRUB MOTOR

The Design Parameters for the Side Scrub Motor modules are shown in the two tables below:

Table 9: Side Scrub Motor Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	S _{TRGT}	Target Speed	-	2320	-	RPM
	t _{TSK}	Task rate	-	50	-	msec
Soft Start	t _{SFTSTART}	Time Interval Configurable in 0.1s increments 0: Disabled	0	0	30	sec

Table 10: Side Scrub Motor Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Open Fault	A _{OPEN}	Open Fault Threshold	-	1	-	A
	t _{OPEN}	Open Fault Time	-	5	-	sec
Hardware Fault	t _{HW}	Open Fault Time	0	5	30	sec
Overtemp Fault	t _{OPEN}	Open Fault Time	-	3	-	msec
Over Voltage Fault	t _{SHORT}	Open Fault Time	-	5	-	sec
Motor Fault	A _{MTR}	Motor Fault Over Current Threshold	-	42	-	A
	S _{MTR}	Motor Fault Speed Threshold	-	500	-	RPM
	t _{MTR}	Motor Fault Time	-	15	-	sec

WATER PICK-UP

WATER PICK-UP CONTROL

The Design Parameters for the Water Pick-Up Control module are shown in the two tables below:

Table 11: Sweep Control Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	t _{SQGPICKUP}	Squeegee Pick Up Delay	-	1	-	sec
	t _{SQGSCRUB}	Squeegee Scrub Delay	-	7	-	sec
	t _{VACSHORT}	Pickup Vac Short Turn Off Delay	-	8	-	sec
	t _{VACSCRUB}	Pickup Vac Scrub Turn Off Delay	-	14	-	sec
	t _{VACSIDE}	Pikcup Vac Side Turn Off Delay	-	21	-	sec

WATER PICK-UP VACUUM

The Design Parameters for the Water Pick-Up Vacuum module are shown in the two tables below:

Table 12: Water Pick-Up Vacuum Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{MTR}	Running Duty Cycle	-	99	-	%
	D _{START}	Starting Duty Cycle	-	25	-	%
	D _{STEP}	Duty Cycle Step	-	5	-	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BAT}	Battery Voltage	25	-	50	V
	V _{ECON}	Economy Mode Operating Voltage	-	28.75	-	V
	V _{TRGT}	Normal Mode Operating Voltage	-	31.5	-	V

Table 13: Water Pick-Up Vacuum Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Open Fault	A _{OPEN}	Open Fault Threshold	-	1.1	-	A
	t _{OPEN}	Open Fault Time	-	5	-	sec

SQUEEGEE ACTUATOR

The Design Parameters for the Squeegee Actuator module are shown in the two tables below:

Table 14: Squeegee Actuator Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{LOWER}	Lowering Duty Cycle	-	66	-	%
	D _{RAISE}	Raising Duty Cycle	-	95	-	%
	t _{TSK}	Task rate	-	50	-	msec

Table 15: Squeegee Actuator Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
General	t _{LOWER}	Lowering Timeout Time	-	10	-	sec
	t _{RAISE}	Raising Timeout Time	-	7.5	-	sec
Stall Fault	A _{LSTALL}	Lowering Stall Fault Threshold	-	15	-	A
	A _{RSTALL}	Raising Stall Fault Threshold	-	15	-	A

SOLUTION CONTROL

This section includes Design Parameters related to the operation of devices related to Solution Control. The Flow Rate Design Parameters are included in the M17 Flow Rate Specification document.

MAIN WATER VALVE

The Design Parameters for the Main Water Valve module are shown in the table below:

Table 16: Main Water Valve Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Hardware Fault	A _{HW}	Threshold	-	80	-	mA
	t _{HW}	Time	-	1	-	sec
Open Fault	A _{OPEN}	Threshold	-	80	-	mA
	t _{OPEN}	Time	-	1	-	sec
Shorted Load	n _{SHORT}	Number of retries	-	3	-	#

DETERGENT PUMP

The Design Parameters for the Detergent Pump module are shown in the two tables below:

Table 17: Detergent Pump Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{MTR}	Max Duty Cycle	-	95	-	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BAT}	Battery Voltage	-	36	-	V
	V _{MTR}	Operating Voltage	-	-	36	V

Table 18: Detergent Pump Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Open Fault	A _{OPEN}	Threshold	-	150	-	mA
	t _{OPEN}	Time	-	1	-	sec
Shorted Load	n _{SHORT}	Number of clipped pulses	-	20	-	#
	t _{SHORT}	Time	-	1	-	sec

SIDE VALVE

The Design Parameters for the Side Valve module are shown in the table below:

Table 19: Side Valve Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Hardware Fault	A _{HW}	Threshold	-	60	-	mA
	t _{HW}	Time	-	1	-	sec
Open Fault	A _{OPEN}	Threshold	-	60	-	mA
	t _{OPEN}	Time	-	1	-	sec
Shorted Load	n _{SHORT}	Number of retries	-	3	-	#

SIDE PUMP

The Design Parameters for the Side Pump module are shown in the two tables below:

Table 20: Side Pump Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{MTR}	Max Duty Cycle	-	95	-	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BAT}	Battery Voltage	-	36	-	V
	V _{MTR}	Operating Voltage	-	-	36	V

Table 21: Side Pump Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Open Fault	A _{OPEN}	Threshold	-	150	-	mA
	t _{OPEN}	Time	-	1	-	sec
Shorted Load	n _{SHORT}	Number of clipped pulses	-	20	-	#
	t _{SHORT}	Time	-	1	-	sec

EXTENDED SCRUB PUMP

The Design Parameters for the Extended Scrub Pump module are shown in the two tables below:

Table 22: Extended Scrub Pump Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{MTR}	Max Duty Cycle	-	95	-	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BAT}	Battery Voltage	-	36	-	V
	V _{MTR}	Operating Voltage	-	-	36	V

Table 23: Extended Scrub Pump Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Open Fault	A _{OPEN}	Threshold	-	30	-	mA
	t _{OPEN}	Time	-	1	-	sec
Shorted Load	n _{SHORT}	Number of clipped pulses	-	20	-	#
	t _{SHORT}	Time	-	1	-	sec

RECOVERY AUTOFILL VALVE

The Design Parameters for the Recovery AutoFill Valve module are shown in the table below:

Table 24: Recovery AutoFill Valve Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Hardware Fault	A _{HW}	Threshold	-	150	-	mA
	t _{HW}	Time	-	1	-	sec
Open Fault	A _{OPEN}	Threshold	-	150	-	mA
	t _{OPEN}	Time	-	1	-	sec
Shorted Load	n _{SHORT}	Number of retries	-	3	-	#

SOLUTION AUTOFILL VALVE

The Design Parameters for the Solution AutoFill Valve module are shown in the table below:

Table 25: Solution AutoFill Valve Module Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Hardware Fault	A _{HW}	Threshold	-	150	-	mA
	t _{HW}	Time	-	1	-	sec
Open Fault	A _{OPEN}	Threshold	-	150	-	mA
	t _{OPEN}	Time	-	1	-	sec
Shorted Load	n _{SHORT}	Number of retries	-	3	-	#

ECH2O

The Design Parameters for the Ech2O module are contained in the design documentation related to Ech2O. The flow rates used when running Ech2O are captured in the M17 Flow Rate Specification document.

SWEEP

SWEEP CONTROL

The Design Parameters for the Sweep Control module are shown in the table below:

Table 26: Sweep Control Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{SLOW}	Slow Speed Duty Cycle	-	50	-	%
	D _{DEFAULT}	Default Speed Duty Cycle	-	95	-	%
	t _{DVAC}	Dust Vac Turn Off Delay	-	1	-	sec
	t _{MSWP}	Main Sweep Actuator Delay before switching to slow speed when retracting	-	9	-	sec
	t _{TSK}	Task rate	-	50	-	msec
Filter Shaker	S _{FLTSHKR}	Filter Shaker Auto Enable Speed	-	2	-	mph
	t _{FLTSHKR}	Filter Shaker Auto Enable Time	-	10	-	sec
	t _{ON}	Filter Shaker On Time	-	30	-	sec

MAIN SWEEP HEAD BRUSH MOTORS

The Design Parameters for the Main Sweep Head Brush Motors module are shown in the two tables below:

Table 27: Main Sweep Head Brush Motors Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{MTR}	Max Duty Cycle	0	99	99	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BAT}	Battery Voltage	-	36	-	V
	V _{MTR}	Operating Voltage	1	30	36	V
Soft Start	t _{SFTSTART}	Time Interval Configurable in 0.1s increments 0: Disabled	0	10	10	sec

Table 28: Main Sweep Head Brush Motors Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Current Limit Fault	A _{LIMIT}	Current Limit	-	40	-	A
Hardware Fault	A _{HW}	Hardware Fault Threshold	0.2	0.2	10	A
	t _{HW}	Hardware Fault Time	0	0.8	15	sec
Open Fault	A _{OPEN}	Open Fault Threshold	0.2	0.2	10	A
	t _{OPEN}	Open Fault Time	0	1	15	sec
Shorted Load	n _{SHRT}	Short Fault Threshold (Pulses)	-	20	-	#
	t _{SHRT}	Short Fault Time	0	5	15	sec

MAIN SWEEP ACTUATOR

The Design Parameters for the Main Sweep Actuator module are shown in the two tables below:

Table 29: Main Sweep Actuator Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{ACT}	Duty Cycle	0	-	95	%
	D _{SPD}	Default Speed Duty Cycle	-	95	-	%
	D _{SSPD}	Slow Speed Duty Cycle	-	50	-	%
	D _{STEP}	Duty Cycle Step Size	-	1	-	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BATT}	No Battery Voltage Compensation	-	-	-	V
Soft Start	t _{SFTSTART}	Soft Start Time	-	0	-	msec

Table 30: Main Sweep Actuator Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
General	t _{RTIMEOUT}	Retract Timeout Time	0	16	30	sec
	t _{ETIMEOUT}	Extend Timeout Time	0	6	30	sec
Stall Fault	A _{STALL}	Current Limit	-	10	-	A
	t _{STALL}	Stall Fault Time	0	0.8	15	sec
Hardware Fault	A _{HW}	Hardware Fault Threshold	0.2	0.5	10	A
	t _{HW}	Hardware Fault Time	0	0.8	15	sec
Open Fault	A _{OPEN}	Open Fault Threshold	0.2	0.2	10	A
	t _{OPEN}	Open Fault Time	0	0.2	15	sec

SIDE SWEEP HEAD BRUSH MOTORS

The Design Parameters for the Side Sweep Head Brush Motors module are shown in the two tables below:

Table 31: Side Sweep Head Brush Motors Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{MTR}	Duty Cycle	0	99	99	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BAT}	Battery Voltage	-	36	-	V
	V _{MTR}	Operating Voltage	1	30	36	V
Soft Start	t _{SFTSTART}	Time Interval Configurable in 0.1s increments 0: Disabled	0	5	10	sec

Table 32: Side Sweep Head Brush Motors Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Current Limit Fault	A _{LIMIT}	Current Limit	-	5	-	A
Hardware Fault	A _{HW}	Hardware Fault Threshold	0.2	0.2	10	A
	t _{HW}	Hardware Fault Time	0	0.8	15	sec
Open Fault	A _{OPEN}	Open Fault Threshold	0.2	0.2	10	A
	t _{OPEN}	Open Fault Time	0	1	15	sec
Shorted Load	n _{SHRT}	Short Fault Threshold (Pulses)	-	20	-	#
	t _{SHRT}	Short Fault Time	0	0.3	15	sec

SIDE SWEEP ACTUATORS

The Design Parameters for the Side Sweep Actuators module are shown in the two tables below:

Table 33: Side Sweep Actuators Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{ACT}	Duty Cycle	0	95	95	%
	t _{TSK}	Task rate	-	50	-	msec
	t _{EXT1}	Timed Position 1	-	2500	-	msec
	t _{EXT2}	Timed Position 2	-	2750	-	msec
	t _{EXT3}	Timed Position 3	-	3000	-	msec
	t _{EXT4}	Timed Position 4	-	3250	-	msec
	t _{EXT5}	Timed Position 5	-	3500	-	msec
	t _{EXT6}	Timed Position 6	-	3750	-	msec
	t _{EXT7}	Timed Position 7	-	4000	-	msec
	t _{EXT8}	Timed Position 8	-	4250	-	msec
	V _{BATT}	Battery Voltage	-	36	-	V
	V _{TARGET}	Target Voltage (when driven at full speed)	-	31.0	-	V

Table 34: Side Sweep Actuators Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
General	A _{LIMIT}	Current Limit	-	10	-	A
	t _{TIMEOUT}	Timeout Time	0	16	30	sec
Stall Fault	n _{STALL}	Stall Fault Clipped Pulses Threshold	-	3	-	#
	t _{STALL}	Stall Fault Time	0	0.8	15	sec
Hardware Fault	A _{HW}	Hardware Fault Threshold	0.2	0.2	10	A
	t _{HW}	Hardware Fault Time	0	0.8	15	sec
Open Fault	A _{OPEN}	Open Fault Threshold	0.1	0.1	10	A
	t _{OPEN}	Open Fault Time	0	1	15	sec

DUST VAC MOTORS

The Design Parameters for the Dust Vac Motors module are shown in the two tables below:

Table 35: Dust Vac Motors Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{MTR}	Single Dust Vac Duty Cycle	0	???	95	%
	D _{MTR}	Dual Dust Vac Duty Cycle	0	???	95	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BAT}	No Battery Voltage Compensation	-	-	-	V

Table 36: Dust Vac Motors Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Underspeed Fault	S _{SPD}	Underspeed Fault Threshold	10	2000	20000	RPM
	t _{SPD}	Underspeed Fault Time	0	5	15	sec

FILTER SHAKER MOTOR

The Design Parameters for the Filter Shaker Motor module are shown in the two tables below:

Table 37: Filter Shaker Motor Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{MTR}	Duty Cycle	0	95	99	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BAT}	Battery Voltage	-	36	-	V
	V _{MTR}	Operating Voltage	1	31.5	36	V
Soft Start	t _{SFTSTART}	Time Interval Configurable in 0.1s increments 0: Disabled	0	0.5	10	sec

Table 38: Filter Shaker Motor Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Current Limit Fault	A _{LIMIT}	Current Limit	-	5	-	A
Hardware Fault	A _{HW}	Hardware Fault Threshold	0.2	0.2	10	A
	t _{HW}	Hardware Fault Time	0	0.8	15	sec
Open Fault	A _{OPEN}	Open Fault Threshold	0.2	0.2	10	A
	t _{OPEN}	Open Fault Time	0	1	15	sec
Shorted Load	n _{SHRT}	Short Fault Threshold (Pulses)	-	20	-	#
	t _{SHRT}	Short Fault Time	0	0.3	15	sec

HOPPER CONTROL

HOPPER CONTROL

The Design Parameters for the Hopper Control module are shown in the table below:

Table 39: Hopper Control Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	t_{MAXHT}	Max Lift Height	-	15	-	sec
	$t_{ROLLOUT}$	Hopper roll out lift height	7	-	7.5	sec
	V_{UNDER}	Hopper Roll Angle under roll out lift height relative to home position	70	-	100	mV
	V_{ABOVE}	Hopper Roll Angle above roll out lift height relative to home position	0	-	800	mV

HOPPER LIFT PUMP

The Design Parameters for the Hopper Lift Pump Motor module are shown in the two tables below:

Table 40: Hopper Lift Pump Motor Module Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{MTR}	Max Duty Cycle	0	-	95	%
	D _{HIGH}	High Speed	-	95	-	%
	D _{LOW}	Low Speed	-	40	-	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BAT}	Battery Voltage	-	36	-	V
	V _{MTR}	Operating Voltage	-	31.5	-	V
Soft Start	t _{SFTSTART}	Time Interval Configurable in 0.1s increments 0: Disabled	-	250	-	sec

Table 41: Hopper Lift Pump Motor Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
Current Limit Fault	A _{LIMIT}	Current Limit	-	40	-	A
	t _{TIMEOUT}	Timeout Time	0	25	30	sec
Hardware Fault	A _{HW}	Hardware Fault Threshold	0.2	0.5	10	A
	t _{HW}	Hardware Fault Time	0	0.8	15	sec
Open Fault	A _{OPEN}	Open Fault Threshold	0.2	0.2	10	A
	t _{OPEN}	Open Fault Time	0	0.2	15	sec
Stall Fault	n _{SHRT}	Short Fault Threshold (Pulses)	-	3	-	#
	t _{SHRT}	Short Fault Time	0	3	15	sec

HOPPER ROLL ACTUATOR

The Design Parameters for the Hopper Roll Actuator module are shown in the two tables below:

Table 42: Hopper Roll Actuator Operation Design Parameters

	Symbol	Description	Min	Typ	Max	Units
General	D _{ACT}	Duty Cycle	0	-	95	%
	D _{HIGH}	High Roll Speed Duty Cycle	-	95	-	%
	D _{LOW}	Low Roll Speed Duty Cycle	-	95	-	%
	t _{TSK}	Task rate	-	50	-	msec
	V _{BATT}	No Battery Voltage Compensation	-	-	-	V
Soft Start	t _{SFTSTART}	Soft Start Time	-	250	-	msec

Table 43: Hopper Roll Actuator Fault Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
General	t _{RTIMEOUT}	Retract Timeout Time	0	16	30	sec
Stall Fault	A _{SEALING}	Sealing Current Limit	-	3.5	-	A
	A _{NORMAL}	Normal Current Limit	-	6.5	-	A
	A _{ROLLOUT}	Roll Out Current Limit	-	5.5	-	A
	t _{STALL}	Stall Fault Time	0	0.25	15	sec
Hardware Fault	A _{HW}	Hardware Fault Threshold	0.2	0.2	10	A
	t _{HW}	Hardware Fault Time	0	5	15	sec
Open Fault	A _{OPEN}	Open Fault Threshold	0.2	0.2	10	A
	t _{OPEN}	Open Fault Time	0	0.2	15	sec

PROPEL

CURTIS

The Design Parameters for the Curtis propel controller module are shown in the table below:

Table 44: iDrive Module Operation Design Parameters

Category	Symbol	Description	Min	Typ	Max	Units
General	V _{HPPR}	Hopper Raised Propel Speed	-	2	-	mph
	V _{SSA}	Side Sweep Adjust Propel Speed	-	2	-	mph
	V _{SCRUB}	Scrub Propel Speed	-	4	-	mph
	V _{TRANSPORT}	Transport Propel Speed	-	5.5	-	mph

APPENDIX A – GLOSSARY

The following glossary provides a brief explanation of some of the terms used in this document.

Battery Capacity – The approximate amount of energy remaining in the battery charge.

Coast Time – The amount of time after a motor turn off command is issued. If a turn on command is issued within this time, the PWM duty cycle is restarted at a higher level than the typical starting duty cycle.

Clipping Percent – The percent number of pulses that were not allowed to fully complete within a task cycle. Clipped pulses occur when current is above the hardware design limit.

Current Offset – A fixed amount of current allowed when zeroing out current reads at board power-up.

Debounce Time – The time allowed for a signal to settle to a constant value before a state change.

Duty Cycle – The percent of time the PWM signal is at high (battery) level. Remainder of time it is off.

Duty Cycle (Start) – The percent signal to begin a motor when starting from an off state. This provides a soft start function.

Duty Cycle (Restart) – If within the coast time, the motor will start at this higher level duty cycle as it is likely to still be spinning. Starting a motor at a lower duty cycle may “brake” a motor from current speed.

Hysteresis – The over shoot of a target that may occur due to hardware behavior.

Period – The total time for a cycle of operation to occur.

PWM – Pulse Width Modulation or the process of reducing the average target voltage by switching at high frequency a fixed voltage on and off.

Samples – The number of data points collected of a value.

Soft Start – The act of gently starting a motor at a low value and ramping up to the target value.

Speed – A percent mapping to a voltage to drive a motor at a portion of its capabilities.

Target – Any value the machine may command for operation.

Task Rate – The time it takes for the software to make changes in operation to or monitor behavior of the controlled device.

Threshold – A measured value in which a limit of operation is expected. This may be a high or low limit.

Turn Off Delay – The amount of time the motor may run after the command to turn off is issued. This may include operating at a different voltage during the delay time.