Volga Wet Scrub Controller Board

Changelog:
REV A--Initial send to layout.
REV B--Fix overlap connection page 8.
--BOM correction J8.
--Add D33, invert sense on power good ckt.
--Add U63,U64,U65 to hold off drivers when keyswitch off.
--Mule board as implemented.

REV C--Add clamps to current references D34,D35,D36.
--Delete U5, use spare section of U11.
REV D--Add FRAM
--Add LEDs
--P1 board as implemented.

REV E--Add .01uF cap to JTAG_RESET for noise suppression.
--Run 3.0V_REF out to deterg pot.
--C181 case style changed from SMT to radial leaded.
--Eliminate U56, U60 level shifters from cell modem.
--Adjust LSin circuits page 2 to pass ESD.
--Add pressure sensor.
--Change R311 to 20.5K.
--Improve accuracy of Vref to A/D.
--Add D9 and remove power source selection resistor jumpers on page 3.
--Add R293 to give higher current options on water pump driver LSD.
--Add C58, C107 in I-drive enable ckt to help RF immunity.
--Eliminate C117, C15 extraneous bypass caps.
--Change accelerometer to SPI interface FXL8471Q. Delete R174,R175, move 3 analog inputs.
--P1.5 boards as released.

REV F--Add current shunt amplifier.
--Edit populate properties to seperate proto with or without telemetry.
--P2 boards as released.

REV G--Merge bus +3.3V_SW back with bus +3.3V
--Change all diodes pin numbering so pin1 is cathode.
--Change resistor pulldowns to 100K to work better at temp<85C: R46,R207,R254,R260,R274
REV H--
--Add U69 to keep I-drive enable off if keyswitch is off.
--Change R214 to 0.1 Ohm to set current limit at 2A for chem pump.
REV I--PP boards.
--Change name of signal BATTERY_LEVEL_SWITCH to ACTUATOR_MIDDLE_SWITCH.
--Add cell modem mounting standoffs.
REV J--PP boards.
--Change R27 to 0 Ohm.

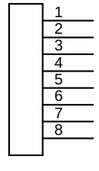
(REFERENCE ONLY) PCA VARIANTS:
STANDARD 1210736
WITH TELEMETRY POPULATED 1215340

LAYOUT FEATURES:

CORNER MOUNTING HOLES

MH1 MH4 MH5 MH2 MH3

HEATSINK MOUNTING HOLES



BOM ITEMS:

FIRMWARE Q30062-001

(SAME FIRMWARE AT THIS TIME)

PCB Q25047-005

SCHEMATIC Q26005-002

ANTENNA CABLE 1070195

TIE WRAP PANDUIT PLT1M

Title: VOLGA WET SCRUB MODULE		
Size: B	Document Number: Q26005-002	Rev: J
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RS-232 SERIAL PORT

DNI FOR PRODUCTION

U49 MAX3232

A JST PH SERIES SMT CONNECTOR 2MM PITCH STRAIGHT UP HEADER

J1 DEBUG PORT

CON3

CAN INTERFACE

ELECTROSTATIC DISCHARGE PROTECTION
over operating free-air temperature range
PARAMETER TEST CONDITIONS VALUE
IEC Contact Discharge IEC 61000-4-2 Bus terminals vs GND ±6 kV
Human Body Model JEDEC Standard 22,Test Method A114-C.01 Bus terminals vs GND ±8 kV
All pins ±4 kV
Field-Induced-Charged Device Model JEDEC Standard 22,Test Method C101 All pins ±1.5 kV
Machine Model ANSI/ESDSS.2-1996 ±200 V

TRANSCEIVER IS AN ENDPOINT.
POPULATE 62 OHM RESISTORS.

U50 SN65HVD1050D

TTL LEVEL INPUTS

NOT POPULATED

DNI FOR PRODUCTION

J2 CON4 VERTICAL

J3 CON4 VERTICAL

GPIOS HAVE SCHMITT TRIGGER INPUTS
GPIO_DEFAULT: PULLDOWN OFF, PULLUP OFF, TRISTATE ON
ACTIVE_GPIO: PRACTICE FOR UNUSED GPIOS IS NC.
All GPIO pins are configured as GPIOs by default with the exception of:
PA1:0 DEFAULTS TO U0RTB
PA5:2 DEFAULTS TO SSI0
PB1:2 DEFAULTS TO I2C0
PC3:0 DEFAULTS TO JTAG

5V TOLERANT INPUTS EXCEPT PB0, PB1

U40 TM4C123GH6PGEI

A/D IS 12 BITS (MAX COUNT 4095)

DIFFERENTIAL SAMPLING IN A/D. AIN8 - AIN9

THIS POWER MONITOR IS USED TO INTERRUPT ON KEYSWITCH TURNED ON.

SPI INTERFACE AUTO DETECT. PIN7 MUST BE FLOATING ON RESET.

U33 FXLS8471Q ACCELEROMETER

U66 MPL3115A2 PRESSURE SENSOR DNI

ADRS 0x00 thru 0x2D

MISC INPUTS

J4 MOLEX MINI-FIT CR VERTICAL TIN

BOARD REVISION BIT DECODER:

BIT	2	1	0	
REV 0	0	0	0	P1 BOARD
REV 1	0	0	1	P1.5 BOARD
REV 2	0	1	0	P2, PP BOARDS
REV 3	0	1	1	

ONLY CHARGES BATTERY WHEN MACHINE IS RUNNING.
ONLY USES BATTERY WHEN MAIN BATTERY IS DISCONNECTED.

ONLY POPULATED ON CELLMODEM VARIANT .

U37 TPS3619 CONTROL IC POWER CONSUMPTION 500nA OVER TEMP RANGE.

POWER FAIL OUTPUT TRIPS AT 2.6V

CR1 ML1220F/FAN BATTERY 3.1V 15mAH

MMBD914

U43 AT45DB081D/SOIC_NARROWANDWIDE

U48 PCF2123 RTC RTC IC POWER CONSUMPTION 330nA OVER TEMP RANGE.

CHIP BONDING PAD IS NC

FSM 32?

U32 FM25CL64 FRAM

JTAG

J5 2213S-10G

Pinout as seen from the top

Pin 7 - JTAG_RTCK NO CONNECT

MICROPROCESSOR

Title	VOLGA WET SCRUB MODULE		
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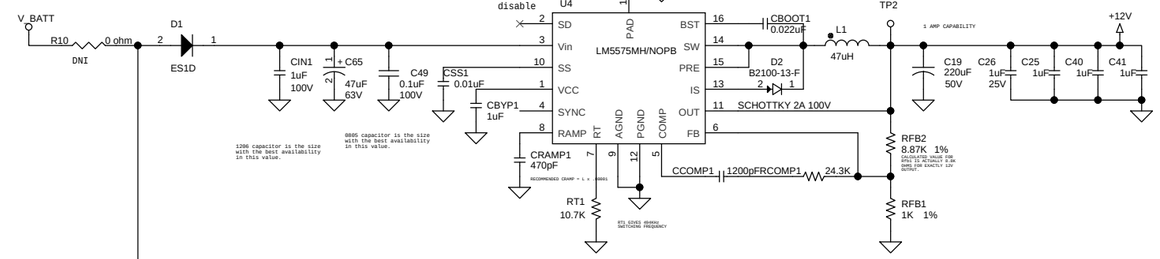
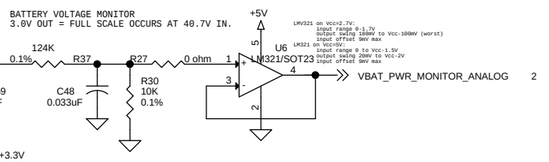
Power Supplies

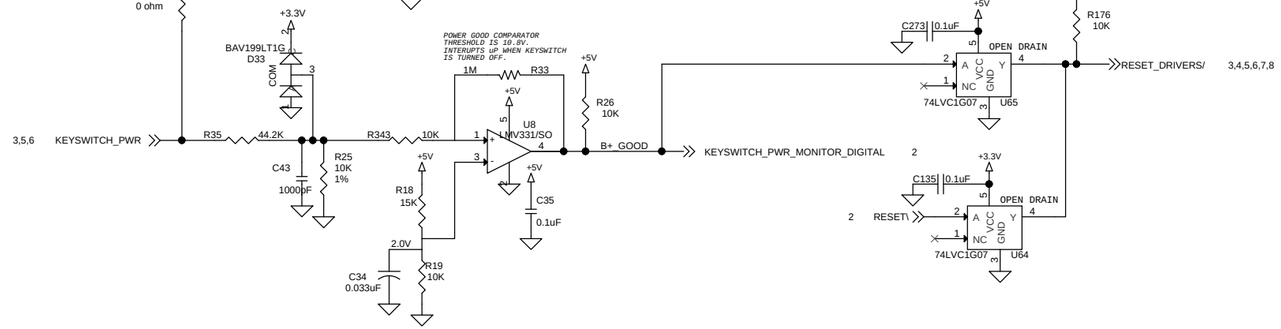
POWER INPUT +24V

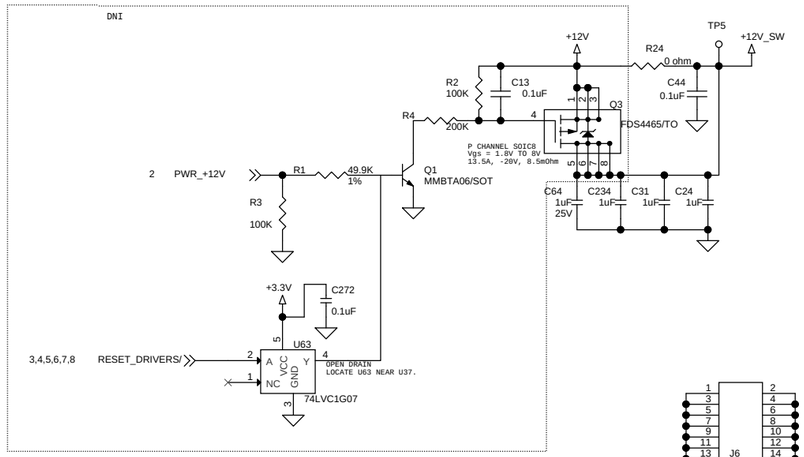
+12V Supply

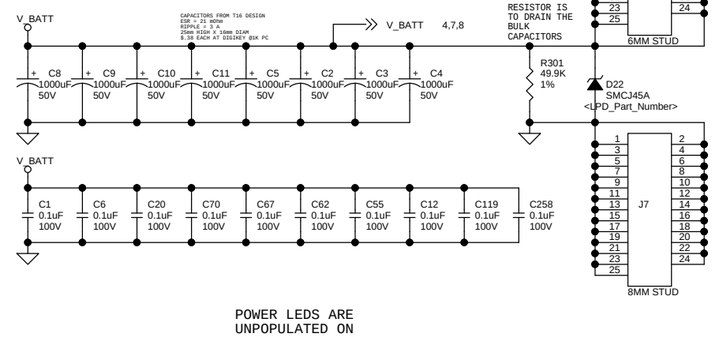
SPECIFICATIONS:
--INPUT VOLTAGE RANGE 20-55V
--MAXIMUM OUTPUT CURRENT 1.0A
--SWITCHING FREQUENCY 500KHz



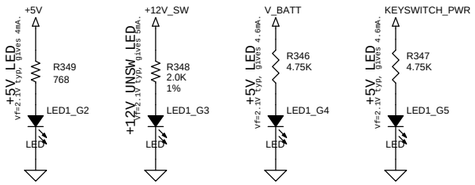


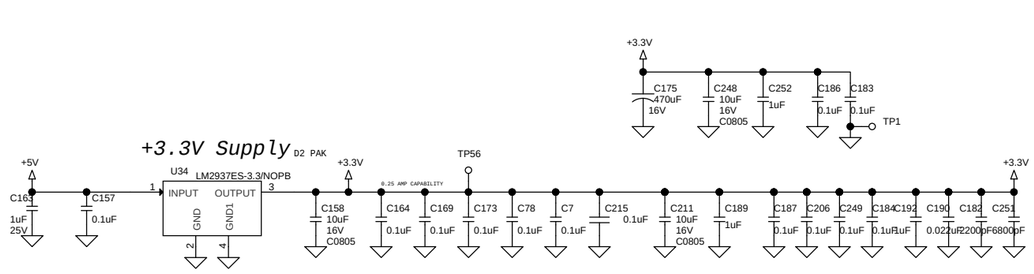


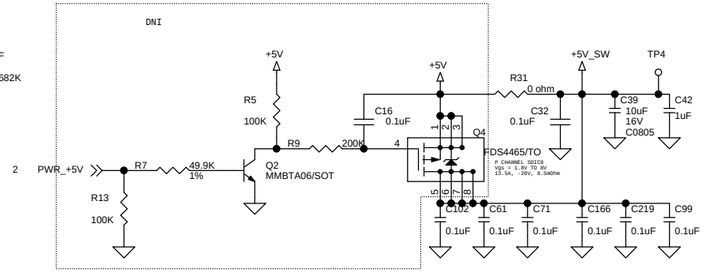


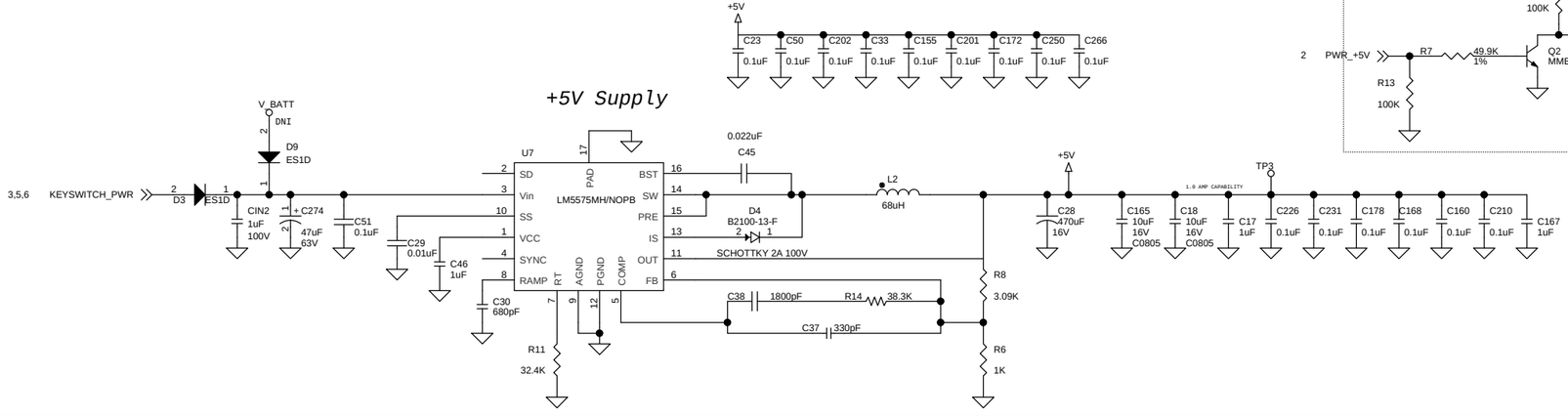


POWER LEDS ARE
UNPOPULATED ON
PRODUCTION VERSIONS.









Power Supplies

Title: VOLGA WET SCRUB MODULE		
Size: C	Document Number: Q26005-002	Rev: J
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Mosfet Driver And Half Bridge

Mosfet Driver And Half Bridge

Current Sense 250mV/Amp

Partial Offset Subtraction

Amplifier

Retriggerable One Shot w/ Reset

On time is 630us, nominal, >500us worst case.

2nd Order Low Pass Filter w/ G=2 and 1kHz cutoff (to be used w/ 33kHz PWM)

Overcurrent Comparator

ACTUATOR_MOTOR_DIRECTION
ACTUATOR_MOTOR_SPEED
RESET_DRIVERS/
ACTUATOR_ENABLE
ACT_CURRENT_SET
ACTUATOR_STATUS
ACTUATOR_A
ACTUATOR_B
ACTUATOR_CURRENT_FEEDBACK
loadStateInB
loadStateInA
8directionBNotA5V
directionANotB5V
desiredPWMActive5V0
enable5vLogic
pwmActual
toCurrentSenseThenGround
currentMeasure2.85VOffset+250mV/A
V_BATT
5vPrecisionRefA
+5V_SW
+12V_SW

Changelog
(visible in digital form):

ACTUATOR FULL BRIDGE DRIVE
EXACT COPY OF VOLGA DRY

Title	VOLGA SCRUB CONTROLLER MODULE		
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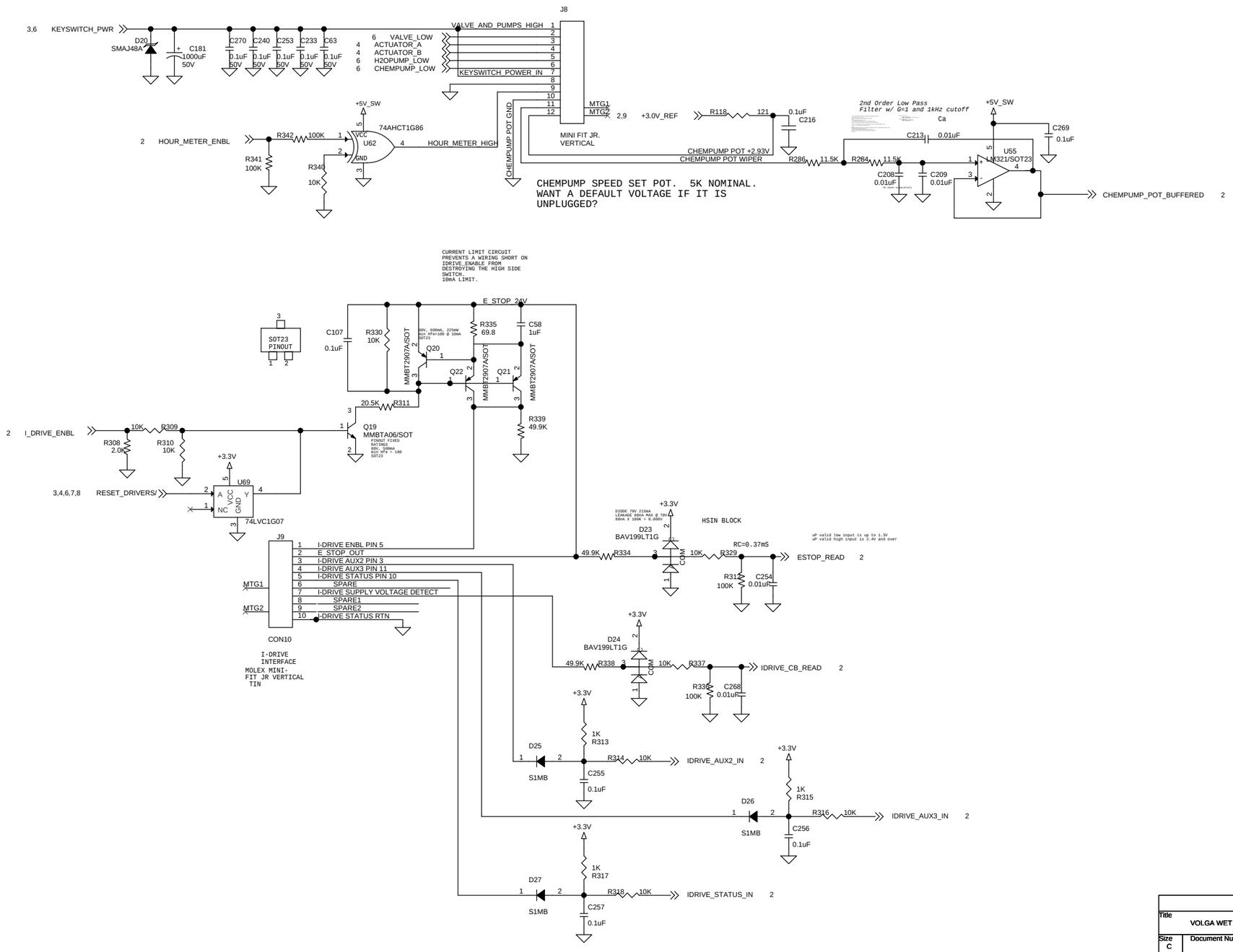
Date: Monday, January 12, 2015	Sheet 4 of 9		



PROPEL INTERFACE

Title	VOLGA WET SCRUB MODULE	
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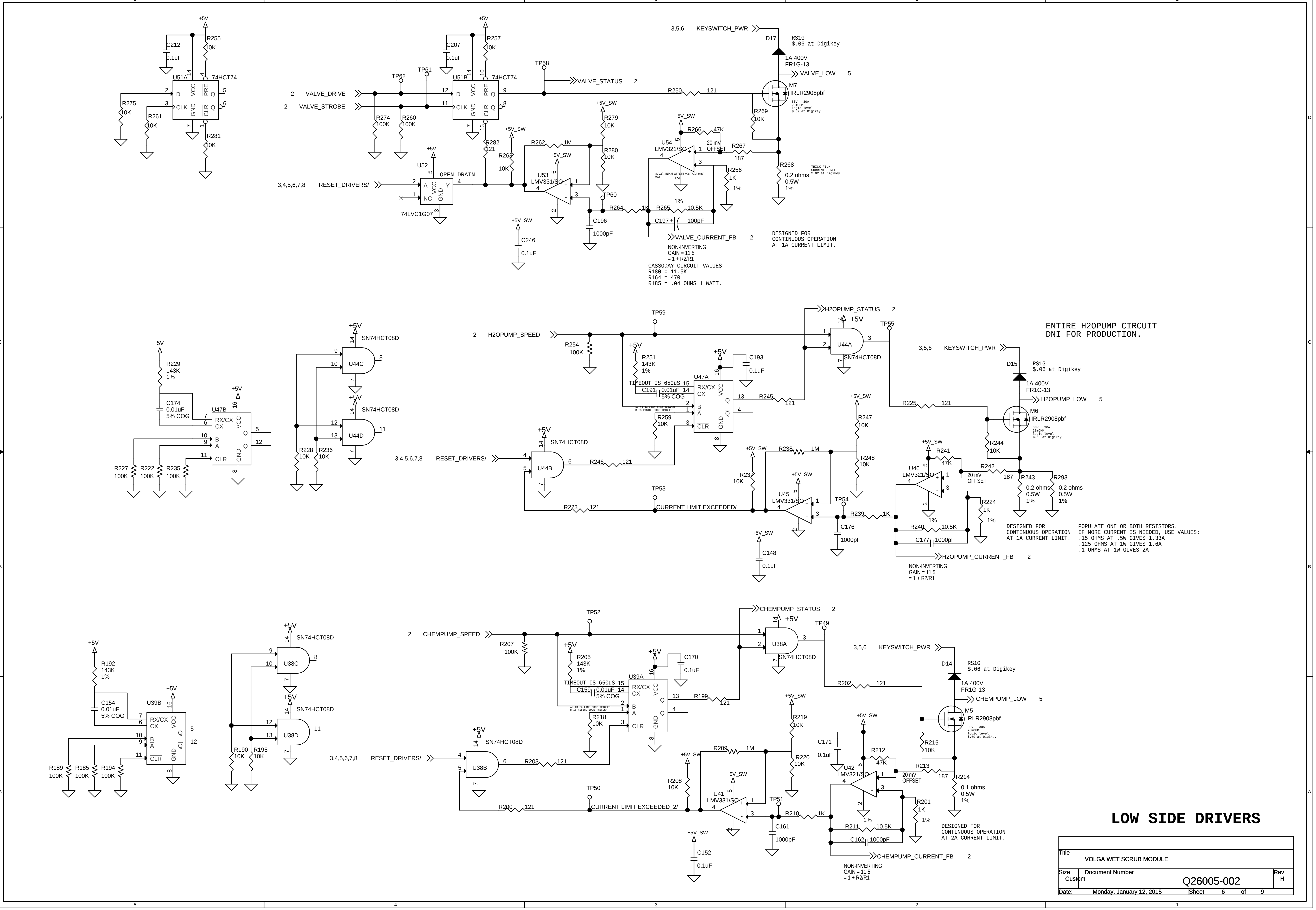
VALVE_DRIVE
VALVE_STROBE
RESET_DRIVERS/
VALVE_STATUS
KEYSWITCH_PWR
VALVE_LOW
VALVE_CURRENT_FB
OPEN DRAIN
NON-INVERTING
GAIN = 11.5
= 1 + R2/R1
CASSODAY CIRCUIT VALUES
R180 = 11.5K
R164 = 470
R185 = .04 OHMS 1 WATT.
DESIGNED FOR
CONTINUOUS OPERATION
AT 1A CURRENT LIMIT.
H2OPUMP_SPEED
H2OPUMP_STATUS
H2OPUMP_LOW
H2OPUMP_CURRENT_FB
ENTIRE H2OPUMP CIRCUIT
DNI FOR PRODUCTION.
TIMEOUT IS 650uS
CURRENT LIMIT EXCEEDED/
POPULATE ONE OR BOTH RESISTORS.
IF MORE CURRENT IS NEEDED, USE VALUES:
.15 OHMS AT .5W GIVES 1.33A
.125 OHMS AT 1W GIVES 1.6A
.1 OHMS AT 1W GIVES 2A
CHEMPUMP_SPEED
CHEMPUMP_STATUS
CHEMPUMP_LOW
CHEMPUMP_CURRENT_FB
CURRENT LIMIT EXCEEDED_2/
DESIGNED FOR
CONTINUOUS OPERATION
AT 2A CURRENT LIMIT.
LOW SIDE DRIVERS
Title
VOLGA WET SCRUB MODULE
Size
Custom
Document Number
Q26005-002
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Mosfet Driver And Half Bridge

3,4,5,6,7,8 RESET_DRIVERS/
2 SCRUB_ENBL
R82 100K
R78 100K
R79 100K
U15C
SN74HCT08D
DISABLE_SCRUB\
5VprecisionRefB
+5V_SW
R67 100K
74AHCT1G86
U12
R56 121
+12V_SW
C93 1uF
D7 S1MB
C84 0.47uF
R57 10K
U17A
HIP4082IBZ
TP13
R59 121
U15D
SN74HCT08D
TP16
R58 49.9K
SCRUB_1_STATUS 2
R109 121
U17B
HIP4082IBZ
R94 45.3
R110 1.1
L5 Ferrite Bead
TP24
Q6 IRFS3206
60V 120A 3mOHM
Q8 FMMT591A/ZTX
C100 0.033uF
TP22
R150 39.0
R142 1.1
L6 Ferrite Bead
TP31
Q11 IRFS3206
Q12 FMMT591A/ZTX
C140 0.033uF
TP43
R87 1.8
C82 2200pF
L8 IHLP6767GZERR47M01
{470nH*.8} IC = 40
D13 SMAJ45A
SCRUB_MOTOR_1_LOW
load is pulled high in case of overcurrent or timeout. - other side of load MUST be connected to vBatt.
V_BATT
C75 1uF 100V
C76 0.1uF 100V
J10
SCRUB MOT HIGH
VAC FAN HIGH
VAC_FAN_LOW
SCRUB MOTOR 1
VAC FAN
MOLEX MINI FIT SR.

Retriggerable One Shot w/ Reset

One Shot is powered by 5V instead of 3.3V to get a quicker response to the reset pin 5ns instead of 270ns. This translates to improved short circuit protection.

TIMEOUT IS 650uS
R91 143K 1%
C95 0.01uF 5% COG
U22A
74HC423D
C89 0.1uF
3,4,5,6,7,8 RESET_DRIVERS/
2 SCRUB_1_SPEED
R73 100K
TP17
R86 100K
U15B
SN74HCT08D
R93 121
R90 100K
R107 121

Current Sense 50mV/Amp

R135 68.1K
R154 768
1%
R177 2m
R173 2m
TP45
Put TP close to resistor
R161 1K
Bias circuitry lifts the 0A condition up to 2.85V. to allow us to read 0amp conditions, and to keep the levels within the comparator's input range.
U27A
OPA2727
R171 49.9K
C137 1uF
C130 0.1uF
TP44
2.85V OFFSET PLUS 50mV PER AMP.

Partial Offset Subtraction

Subtracts 2.5V +-30mV of the offset, leaving just .35V +-180mV. The rest is auto-zeroed out by the micro.
U35
LM4040CIM3-2.5
C151 0.1uF
R182 1K
TP46
.35V OFFSET PLUS 50mV PER AMP.

Buffer/Filter

U36
LMV321/SO
R180 1K
RC = 10uS +/-20%
TP57
SCRUB_1_CURRENT_FB 2
C149 0.01uF

U10
LP2980AIM5-5.0/NOPB
C73 1uF
C74 0.1uF

Current Reference

2nd Order Low Pass Filter w/ G=2 and 1kHz cutoff (to be used w/ 33kHz PWM)

R47 10K
U15A
SN74HCT08D
2 SCRUB_1_CURRENT_SET
R70 100K
R54 100K
R162 11.5K
R156 11.5K
C114 0.01uF
C110 0.01uF
Ca
C120 0.01uF
C128 0.1uF
U27B
OPA2727
R169 200
D34 BAV199LT1G
+5V
TP42
C134 0.1uF
R134 10K
R158 10K

Overcurrent Comparator

Diode clamps the negative voltage voltage at -0.7V so it is not possible to set an overcurrent level of more than ~5SA.

This circuit has about 25mV of hysteresis (+-12.5mV) in it.

R143 1M
+12V_SW
C133 0.1uF
R144 10K
TP28
R168 4.99K
U29B
LM319MX
R170 10K
U29A
LM319MX
R160 10K
SPARE

R119 143K 1%
C103 0.01uF 5% COG
U22B
R123 100K
R128 100K
R116 100K

Changelog
(visible in digital form):

SCRUB MOTOR HALF BRIDGE

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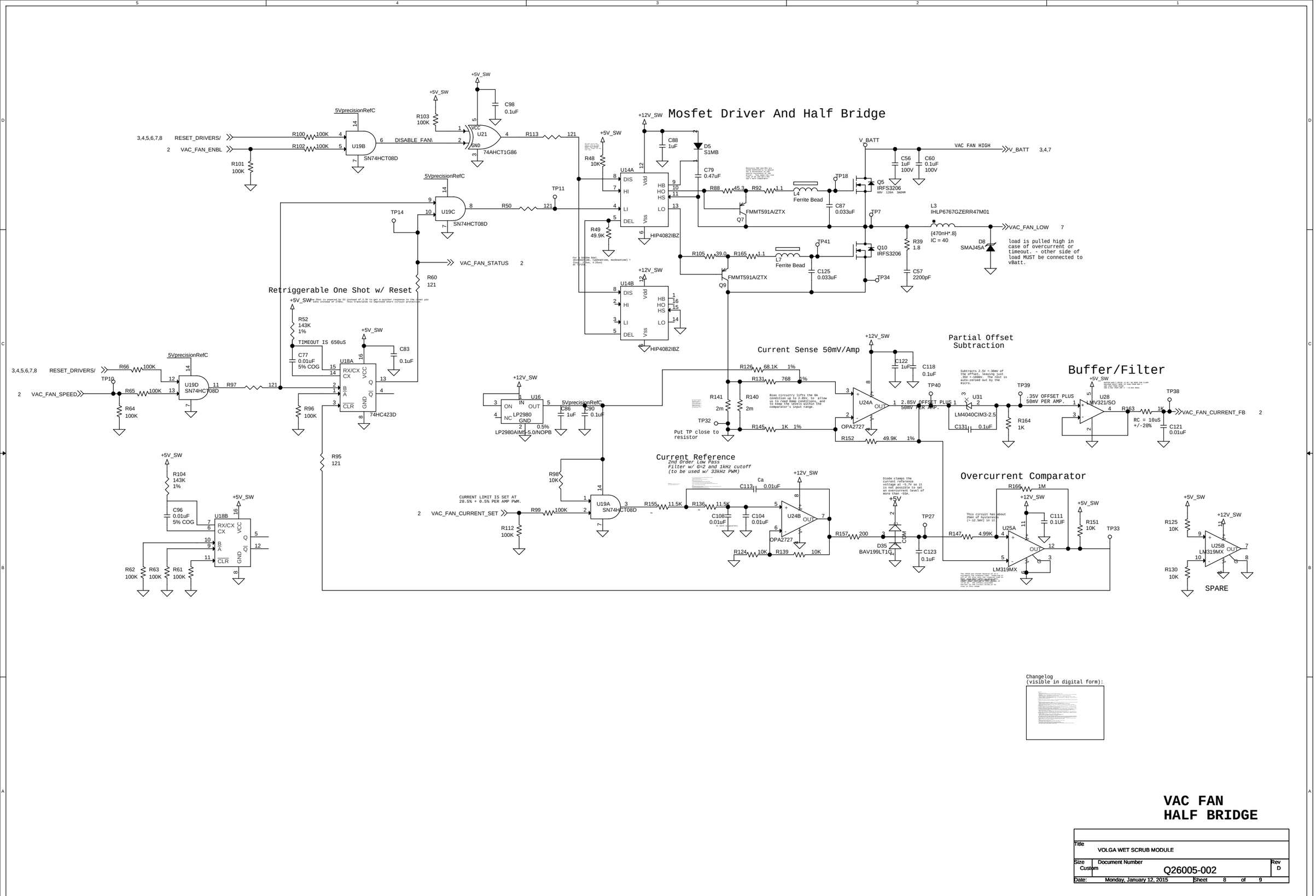
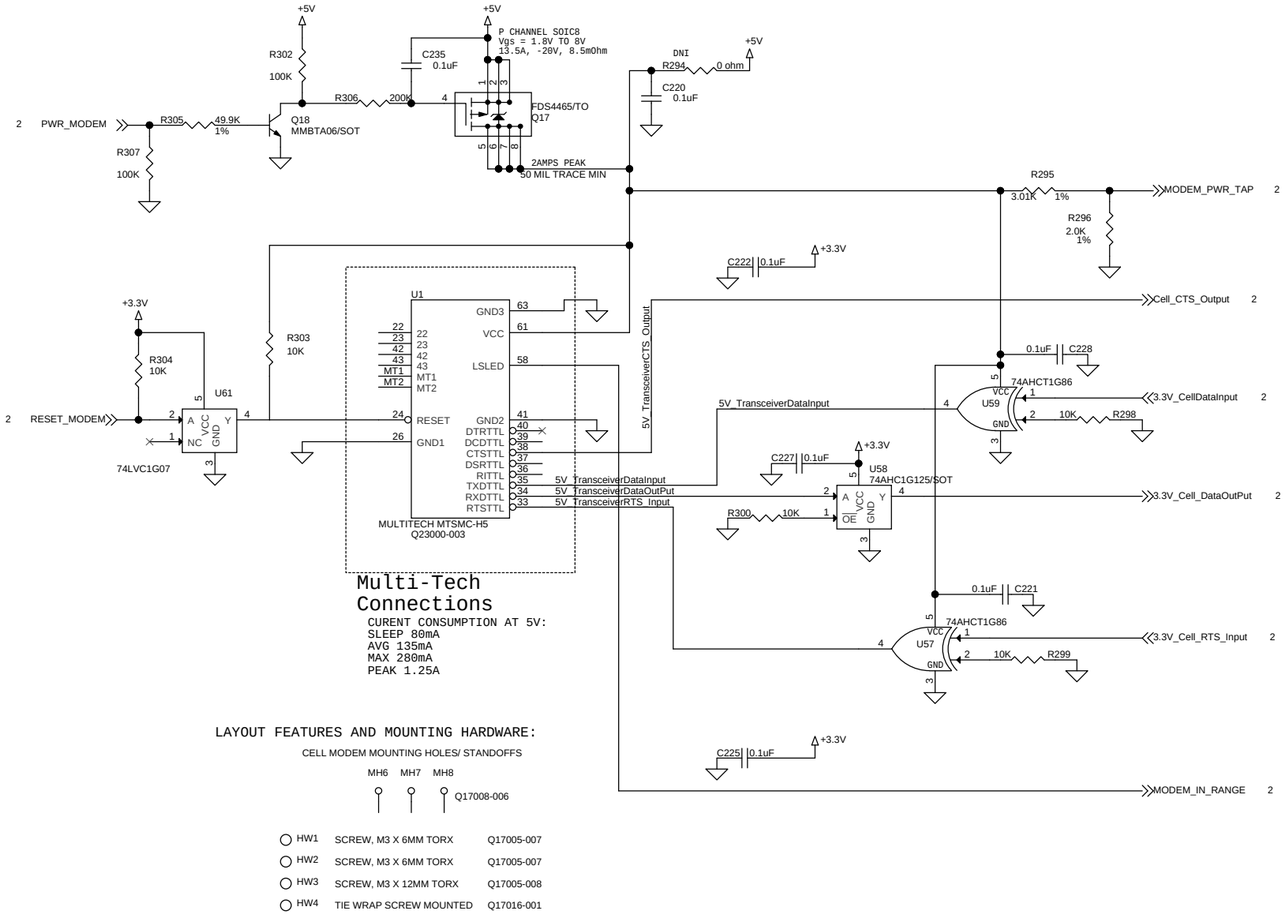

Mosfet Driver And Half Bridge
Retriggerable One Shot w/ Reset
Current Sense 50mV/Amp
Partial Offset Subtraction
Buffer/Filter
Current Reference
2nd Order Low Pass Filter w/ G=2 and 1kHz cutoff (to be used w/ 33kHz PWM)
Overcurrent Comparator
SPARE
load is pulled high in case of overcurrent or timeout. - other side of load MUST be connected to vBatt.
Put TP close to resistor
CURRENT LIMIT IS SET AT 28.5% + 0.5% PER AMP PWM.
Changelog
(visible in digital form):
VAC FAN HALF BRIDGE
VOLGA WET SCRUB MODULE
Q26005-002
Monday, January 12, 2015
Sheet 8 of 9

MODEM WAS POWERED ALL THE TIME ON PROTOS. WHAT TO DO IN PRODUCTION?



Multi-Tech Connections

CURENT CONSUMPTION AT 5V:
SLEEP 80mA
AVG 135mA
MAX 280mA
PEAK 1.25A

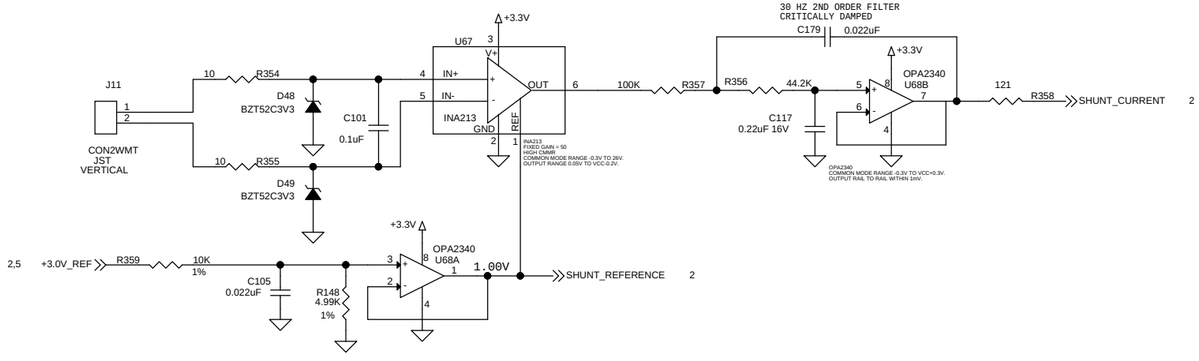
LAYOUT FEATURES AND MOUNTING HARDWARE:

CELL MODEM MOUNTING HOLES/ STANDOFFS

MH6 MH7 MH8 Q17008-006

HW1	SCREW, M3 X 6MM TORX	Q17005-007
HW2	SCREW, M3 X 6MM TORX	Q17005-007
HW3	SCREW, M3 X 12MM TORX	Q17005-008
HW4	TIE WRAP SCREW MOUNTED	Q17016-001

SHUNT SPECS 50mV AT 250A.
200 AMPS THRU SHUNT == 2.0 VOLT OUTPUT + 1.0V REF = 3.0V
-100 AMPS THRU SHUNT == -1.0 VOLT OUTPUT + 1.0V REF = 0V



CELL MODEM.
BATTERY CURRENT SHUNT AMPLIFIER.

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