Primary System Power Channel
Group1

Pack 1
Nominal
28V to 14V

J1
TE/0.156/3x1
3 GND
2 PACK1-IN
1 GND

Pack ORing diodes
380mV@2A, 465mV@10A
-30uA@-30V at 25C

D1, D3
SBR10U45SP5-13/PowerDI5

Battery Disconnect
With Turn-On Delay
4.5V full disconnect
6V full connect

R57
4.02M/0603

C1
6.8uF/50V/1206

D2
BZT52C10-7-F/SOD-123

Q1
SUM110P04-05/D2Pak
5mOhm Rds(on)

R2
2M/0603

D4
SMBJ28A/SMB

Leakage
1uA max
at 28V

C12
10000uF/35V/22Dx50L

Cap discharge

V-CAP-SYS
TP1
V-CAP-SYS

J2
Molex/0.1/2x1

R1
1k/2010

R55
1k/2010

D5
LTST-C150AKT/1206

C2
4.7uF/50V/1206

Switching power supply 3.3V, 500mA
Group3

12uA Quiescent current
Efficiency:
81% at 1mA, 87mA at 10mA,
88% at 100mA; 87% a500mA

U1
LTC3630/MSE16
VIN
RUN
FBO
GND8
GND14
GND16
GND17
SW
VFB
ISET
SS
VPRG1
VPRG2

SW-L
L1 68uH/12.5x12.5

R3
220k/0603

C9
220pF/0805

+3.3CONVERTER

C13
100uF/10V/1206

C14
100uF/10V/1206

C7
100uF/10V/1206

C10
100uF/10V/1206

C5
100uF/10V/1206

3.3V Digital
Group4

TP2
+3.3V/RED

+3.3V

L2
125ohm/8A/1812
10mOhm max

C15
100uF/10V/1206

C8
10uF/25V/1206

C6
1.0uF/0805

C3
0.1uF/0805

GND

TP4
GND/Black

3.3V Digital Quiet
Group5

TP3
+3.3VDQ/RED

+3.3VDQ

L3
120ohm/200mA/0805
190 mOhm max

L4
1000uH/85mA/2220
12 Ohm max

C4
1.0uF/0805

C11
100uF/10V/1206

C16
10uF/25V/1206

L5
120ohm/200mA/0805
190 mOhm max

TP5
AGND/Black

AGND

Modem Power Channel
Group2

Pack 2
Nominal
28V to 14V

J3
TE/0.156/3x1
3 GND
2 PACK2-IN
1 GND

Pack ORing diodes
380mV@2A, 465mV@10A
-30uA@-30V at 25C

D6, D9
SBR10U45SP5-13/PowerDI5

Battery Disconnect
With Turn-On Delay
4.5V full disconnect
6V full connect

R58
4.02M/0603

C17
6.8uF/50V/1206

D7
BZT52C10-7-F/SOD-123

Q2
SUM110P04-05/D2Pak
5mOhm Rds(on)

R12
2M/0603

D10
SMBJ28A/SMB

Leakage
1uA max
at 28V

C21
10000uF/35V/22Dx50L

Cap discharge

V-CAP-MODEM
TP6
V-CAP-MODEM

J4
Molex/0.1/2x1

R8
1k/2010

R56
1k/2010

D11
LTST-C150AKT/1206

D8
BZT52C10-7-F/SOD-123

R4
2M/0603

R7
1M/0603

Q3
SUM110P04-05/D2Pak
5mOhm Rds(on)

Q4
BSS138-7-F/SOT-23

R14
1M/0603

MODEM-ENBL

R15
1k/0603

Modem Power

J5
TE/0.156/2x1
2:PWR
1:GND

TP18
GND/Black

Power Enable Modem
Group6

Modem-Min Voltage Tracker
Time constantants: 20ms down, 40s up,
130us LPF;
Voltage divider 2180/180 = 12.11
Full scale 30V/ 12.11 = 2.47V

Group7

+3.3VDQ

U3
LT6003/TSOT23-5

R5
2M/0603

R10
180k/0603

C20
68pF/0805

R9
2M/0603

R11
1k/0603

D12
BAT43W/SOD-123

R59
180k/0603

C19
33uF/6.3V/1206

U20
LT6003/TSOT23-5

R54
1k/0603

C18
0.1uF/0805

U2
LT6003/TSOT23-5

R6
2M/0603

C22
0.047uF/0805

R13
180k/0603

V-MODEM-MIN

V-SYS

System Voltage Monitor
with 100ms LPF

Group8

J12
TE/0.1/3x1
Power Test
3: PACK1
2: GND
1: PACK2

MH1 MTHOLE0.129
MH2 MTHOLE0.129
MH3 MTHOLE0.129
MH4 MTHOLE0.129
MH5 MTHOLE0.129
MH6 MTHOLE0.129

MOB1 to MOB2 revision:
R55: 1k/2010 added
R56: 1k/2010 added
R57: 4.02M/0603 added
R58: 4.02M/0603 added
R59: 180k/0603 added
J12: Molex C-grid 3x1 added

MOB2 to MOB3 Revision

POWER-ON Generator
0.5V x 12.11 scale=
=6V threshold on
V-CAP-SYS voltage

U??
LT6003/TSOT23-5
R?? 1M/0603
R?? 4.99k/0603
R?? 178k/0603
C?? 0.047uF/0805
R?? 4.99k/0603
POWER_ON
J??
Molex/0.1/2x1

Install Jumper
for manual SD
Card Shutdown

Rev0(01/24/2013): Initial Release
Rev1(05/07/2013): C1,C17(2.2uF to 6.8uF+4M), R2,R12(1M to 2M), R55,R56(1k, added), L3(1k to 120ohm), L5(600ohm to 120ohm), C11(10uF to 100uF), C19(10uF to 33uF), cont. Page2

MBARI	Monterey Bay Aquarium Research Institute 7700 Sandholdt Rd, Moss landing CA 95076		
Engineer: Klimov 831-775-1914	Page Title: BEDS Mother Board/ Power		Project: 901006
Size: B	Doc. or Part Number: <Doc>	File Name (auto): 10020895-MOB3	Rev: 0
Page Modify Date (auto):	Thursday, February 22, 2018	Sheet: 1 of 4	
Design Modify Date (auto):	Thursday, February 22, 2018		
Full path (auto): U:\ORCAD PROJECTS\BEDS\10020895-MOB3\10020895-MOB3.DSN			

+5 Analog with Sensor Power Enable

Group9

Reference 5V / 2= 2.5V
Low-pass filter 5ms

Group10

External 3-wire Pressure Sensor Interface
0-70 BAR ABsolute, Ratiometric, 0.5-4.5V Output
Power 5V, 3mA. Output resistance 100 Ohm
US331-000004-070BA

Group11

~560mV @ 1 BAR nominal

Internal 3-wire Pressure Sensor Interface
100PSI Absolute, Ratiometric, 0.5-4.5V Output
Power 5V, 2.5mA, 5k minimum load

Group12

Low-pass filter 5ms

~1.100V @ 15 PSIA nominal

V-CAP-SYS
L6
120ohm/200mA/0805
190 mOhm max
L7
100uH/250mA/2220
1.6 Ohm max
C25
2.2uF/50V/1206
C28
2.2uF/50V/1206
U4 LT3010/8-MSOP
IN
OUT
/SHDN
Sense
GND9
GND4
+5V
TP7
+5V/RED
C26
2.2uF/50V/1206
R18 1M/0603
R20 1k/0603
SENSORS-ENBL
AGND
R16
50k/50k/0.035%/SOT23
R1
R2
C31
0.1uF/0805
U7
LT6003/TSOT23-5
C23
0.1uF/0805
J6
MOLEX/C-GRID/4X1
R17
50k/50k/0.035%/SOT23
C29
0.1uF/0805
U5
LT6003/TSOT23-5
C24
0.1uF/0805
U6
Pressure
NC5
NC6
NC7
NC8
Vsup
Vout
GND
NC4
ASDXACX100PAAA5/DIP-8
R66
4.99k/0603
R19
50k/50k/0.035%/SOT23
C30
0.1uF/0805
U8
LT6003/TSOT23-5
C27
0.1uF/0805
~550mV @ 15 PSIA nominal
~280mV @ 1 BAR

Group13

+3.3V Analog

Temperature Sensor
500mV + 10mV/C
+/- 0.5C Nominal
35uA

Humidity Sensor
0.5 - 2.5V Output
+/-3% Accuracy
5s 1/e Responce Time
200uA

R28
49.9k/0603
U12
LT6003/TSOT23-5
R34
100k/0603
R25 1k/0603
R26 100/0603
U10
Tempr
10mV/C
+500mV
VDD
VOUT
VSS
TC1047AVNBTR/SOT-23
C33
330pF/0805
U11
RH%
+VE
NC
OUT
RH%
-VE
HIH-5030-001
C34
330pF/0805
R35
49.9k/0603
TEMP
RH

V-SYS
TP8
Vmodem
TP9
Pext
TP10
Pint
TP11
V-SYS
V-MODEM-MIN
PR-EXT
PR-INT
TEMP
RH
R22 4.99k/0603
R23 4.99k/0603
R24 4.99k/0603
R27 4.99k/0603
R29 4.99k/0603
R30 4.99k/0603
R32 4.99k/0603
R33 4.99k/0603
TP12
CH7
TP13
CH6
TP14
RH
TP15
TEMP
C43
1.0uF/0805
C44
1.0uF/0805
C41
1.0uF/0805
C39
1.0uF/0805
C40
1.0uF/0805
C38
1.0uF/0805
C36
1.0uF/0805
C37
1.0uF/0805
TP16
AGND/Black
ADC-ENBL

Low-pass filters 0.1ms

Group14

8-channel ADC, single-ended config.
3.3V Digital, 2.5V Reference
1.2mA

inp leakage +/- 1uA

+3.3VDQ
U9
CH0
CH1
CH2
CH3
CH4
CH5
CH6
CH7
COM
/SHDN
Vcc1
DCLK
/CS
Din
BUSY
Dout
GND1
GND2
Vcc2
Vref
ADS8344/SSOP-20
SCK2
/ADC-CS
MOSI2
49.9/0603
R??
MISO2
V-REF
R31
4.99k/0603
C32
1.0uF/0805
C35
0.1uF/0805
C42
0.1uF/0805
C51
10uF/25V/1206
AGND
TP19
V-REF

HIH-5030-001 calc humidity calc:
Vout=Vsup*(0.00636*RH+0.1515)
RH=(Vout/Vsup-0.1515)/0.00636

MOB1 to MOB2 revision:
C51: 10uF/25V/1206 added
TP19: V-REF added
R66: 4.99k/0603 added

Rev2 (cont. from Page1): L6(1k/200mA to 120oHm/200mA), R25(100 to 1k), C33,C34(0.1uF to 330pF), R22-R33(1k to 5k), C37-C41,C43,C44(0.1uF to 1.0uF), C42(0.1uF to 0.1uF+10uF), R31(1k to 5k), cont. to Page3

MBARI	Monterey Bay Aquarium Research Institute 7700 Sandholdt Rd, Moss landing CA 95076		
Engineer Klimov 831-775-1914	Page Title BEDS Mother Board/ Sensors	Project: see page 1	
Size B	Document Number see page 1	File Name (auto) 10020895-MOB3	Rev see page 1
Page Modify Date (auto): Design Modify Date (auto):	Thursday, February 22, 2018 Thursday, February 22, 2018	Sheet: 2 of 4	
Full path (auto): U:\ORCAD PROJECTS\BEDS\10020895-MOB3\10020895-MOB3.DSN			

Test Conn 1

TEST_3 5
TEST_2 4
TEST_1 3
TEST_0 2
GND 1

skip/TestPoint J??

Test Conn 2

TEST_7 5
TEST_6 4
TEST_5/RXD3 3
TEST_4/TXD3 2
GND 1

skip/TestPoint J??

TP?? /ADC_CS

NEEDS TO BE LOW ESR

GND C?? 10uF/16V/1206

/IMU_ENBL
/IMU_CS
/IMU_INT

TP?? /IMU_CS

+3.3V

C?? 0.1uF/0805
C?? 0.1uF/0805
C?? 0.1uF/0805

GND

SPI Bus1
RTS&IMU
page3

/RTC_CS
/RTC_INT
POWER_ON
MISO1
SCK1
MOSI1
IMU_IO2
IMU_IO1

R?? 49.9/0603 SCK1
R?? 49.9/0603 MOSI1

SPI Bus2
SD/page3
ADC/page2

MOSI2
CARD_DET
/SD_CS
MISO2
SCK2

R?? 49.9/0603

TXD1
RXD1
/MCLR
ADC-ENBL

RS232
page3

ADC
page2 /ADC-CS

RS232 /SER_EN
page3 /SER_SHDN

ICSP
CONN
page3

PGEC
PGED

U? PIC32MX470F512L-I/PF

RG15
VDD
AN22/RPE5/PMD5/RE5
AN23/PMD6/RE6
AN27/PMD7/RE7
RPC1/RC1
RPC2/RC2
RPC3/RC3
RPC4/CTED7/RC4
AN16/C1IND/RPG6/SCK2/PMA5/RG6
AN17/C1INC/RPG7/PMA4/RG7
AN18/C2IND/RPG8/PMA3/RG8
MCLR
AN19/C2INC/RPG9/PMA2/RG9
VSS
VDD
TMS/CTED1/RA0
RPE8/RE8
RPE9/RE9
AN5/C1INA/RPB5/VBUSON/RB5
AN4/C1INB/RB4
PGED3/AN3/C2INA/RPB3/RB3
PGEC3/AN2/C2INB/RPB2/CTED13/RB2
PGEC1/AN1/RPB1/CTED12/RB1
PGED1/AN0/RPB0/RB0

AN21/PMD4/RE4
RPE3/CTPLS/PMD3/RE3
AN20/PMD2/RE2
TRD0/RG13
TRD1/RG12
TRD2/RG14
PMD1/RE1
PMD0/RE0
TRD3/CTED8/RA7
TRCLK/RA6
RPG0/PMD8/RG0
RPG1/PMD9/RG1
RPF1/PMD10/RF1
RPF0/PMD11/RF0
VDD
VCAP
PMD15/RD7
PMD14/RD6
RPD5/PMRD/RD5
RPD4/PMWR/RD4
PMD13/RD13
RPD12/PMD12/RD12
AN26/RPD3/RD3
AN25/RPD2/RD2
AN24/RPD1/RD1

VSS
SOSCO/RPC14/T1CK/RC14
SOSCI/RPC13/RC13
RPD0/INT0/RD0
RPD11/PMCS1/RD11
RPD10/PMCS2/RD10
RPD9/RD9
RPD8/RTCC/RD8
SDA1/RPA15/RA15
SCL1/RPA14/RA14
VSS
OSC2/CLKO/RC15
OSC1/CLKI/RC12
VDD
TDO/RA5
TDI/CTED9/RA4
SDA2/RA3
SCL2/RA2
D+
D-
VUSB3V3
VBUS
RPF8/RF8
RPF2/RF2
USBID/RPF3/RF3

OSC2
OSC1

C?? 18pF/1%/0805
Y1 24MHz 445C25D24M00000
C?? 18pF/1%/0805

GND

PGEC2/AN6/RPB6/RB6
PGED2/AN7/RPB7/CTED3/RB7
VREF-/CVREF-/PMA7/RA9
VREF+/CVREF+/PMA6/RA10
AVDD
AVSS
AN8/RPB8/CTED10/RB8
AN9/RPB9/CTED4/RB9
CVREFOUT/AN10/RPB10/CTED11PMA13/RB10
AN11/PMA12/RB11
VSS
VDD
TCK/CTED2/RA1
RPF13/RF13
RPF12/RF12
AN12/PMA11/RB12
AN13/PMA10/RB13
AN14/RPB14/CTED5/PMA1/RB14
AN15/RPB15/OCFB/CTED6/PMA0/RB15
VSS
VDD
RPD14/RD14
RPD15/RD15
RPF4/PMA9/RF4
RPF5/PMA8/RF5

+3.3V
C?? 0.1uF/0805
C?? 0.1uF/0805
GND

SENSORS-ENBL
MODEM-ENBL

page 2
page 1

RXD2
TXD2

+3.3V
C?? 0.1uF/0805
C?? 0.1uF/0805
C?? 0.1uF/0805
GND

Micro SD Card

SHILED15
SHILED14
SHILED13
SHILED12
SHILED11

GND
SWITCH

CARD_DET
D1
DO
VSS
CLK
VDD
CMD
D3/CD
D2

R?? 49.9/0603 MISO2
SCK2
SD_VDD
MOSI2
/SD_CS

J? 5031821853

SPI Bus2 Test

MISO2
SCK2
MOSI2
/SD_CS
GND

J?? skip/TestPoint

+3.3V

L?? 120ohm/200mA/0805 190 mOhm max

10uF/16V/1206 C??
C?? 0.1uF/0805
GND

The SPI bus specifies four logic signals:
SCLK: Serial Clock (output from master)
MOSI: Master Out Slave In (data output from master)
MISO: Master In Slave Out (data output from slave)
SS: Slave Select (often active low, output from master)

R?? 49.9/0603 MISO1

U18A

MOSI1
SCK1
IMU_IO1

Main-SDA-X
COMPASS-RDY
A5
A7
GND

Main-SCL-X
MPU-IRQ-X
A6
PWR-EN-X
PWR

/IMU_INT
/IMU_CS
/IMU_ENBL
IMU_IO2

GND
+3.3V

MPU-6050/Conn5x2/2x

U18B

MPU-6050/Conn5x2/2x

Serial Port Controller 0.3mA; 1uA in shutdown
Group19

U13

TXD1
TXD2
RXD1
RXD2

DIN1
DIN2
ROUT1
ROUT2
C1+
C2+
C2-
C1-
EN
PWRDOWN

DOUT1
DOUT2
RIN1
RIN2
V-
V+
VCC
GND
NC11
NC14

C45 0.1uF/0805
C46 0.1uF/0805
C47 0.1uF/0805
C48 0.1uF/0805
C49 0.1uF/0805

/SER_EN
/SER_SHDN

MAX3222/20-SOIC

+3.3V
GND

Modem J7

RxD
TxD
GND

MOLEX/C-GRID/5X1

Debug J8

RSRXD
RSTXD
GND

MOLEX/C-GRID/5X1

Reset 3-Way Combiner

/MCLR
+3.3V

S3 RESET R?? 100/0603
R?? 10k/0603
R?? 100/0603
R63 skip/1k/0603

GND

J??

MCLR
vdd
GND
PGD
PGC
PGM

PGED
PGEC

C?? 0.1uF/0805
GND

Molex/0855135014

ICSP CONNECTOR 6 PIN MODULAR

SPI Bus RTC with Integrated Crystal and SRAM
400uA active, 120uA standby

TP17 32kHz
+3.3V
/RTC_CS
/RTC_INT

Group18

U19

/CS
NC2
32kHz
VCC
INT/SQW
/RST
NC7
NC8
NC9
NC10

SCLK2
DOUT
SCLK1
DIN
VBAT
GND
NC14
NC13
NC12
NC11

C50 0.1uF/0805

R?? 49.9/0603
R52 100/0603

MISO1
SCK1
MOSI1

J11 BU2032-1-HD-G
VBBK

BATT1
CR2032/20mm/3V

DS3234S/20-SOIC

GND

SPI Bus1 Test

J??

MISO1
SCK1
MOSI1
/RTC_CS
GND

skip/TestPoint

Reset by Modem Release Enable
3.3V active, 50mS low pass filter

+3.3V

R65 skip/1k/0603

J14

MOLEX/C-GRID/3X1

Reset Input
From Modem
3:RELEASE SENSE
2:RELEASE ENABLE
1:GND

R62 49.9k/0603
R64 skip/1k/0603
R61 1k/0603
C52 1.0uF/0805

GND

FDS4897AC/SO-8
U21A

FDS4897AC/SO-8
U21B

Monterey Bay Aquarium Research Institute 7700 Sandholdt Rd, Moss landing CA 95076			
Engineer Klimov 831-775-1914	Page Title BEDS Mother Board/ Persistor		Project: see page 1
Size B	Document Number see page 1	File Name (auto) 10020895-MOB3	Rev see page 1
Page Modify Date (auto): Design Modify Date (auto):	Thursday, February 22, 2018 Thursday, February 22, 2018	Sheet: 3 of 4	
Full path (auto): U:\ORCAD PROJECTS\BEDS\10020895-MOB3\10020895-MOB3.DSN			

Bring-up Checklist
Fully assembled Mother Board, no Persistor Board, no MPU-6050 board. Set power supply to 12V, power up.

0. Connect jumpers to J2 and J4, verify LEDs light up, record PS current with and withoud LEDs running

1. Check voltage level and noise on 3.3V (TP2) with test load on 3.3V, 100mA (33 Ohm) and 200mA (16 Ohm)

2. Check voltage level and noise on 3.3VDQ (TP3) with 100mA (33 Ohm) test load on 3.3V power

3. Check operation of Modem_Enable with 5 Ohm 50W test load in J5 (2.3A).

4. Measure V-CAP-MODEM (TP6), voltage at J5.2, and difference between them (<50mV)

5. Check V-SYS (TP8) and V-MODEM-MIN (TP9) trackers with Modem-ENBL cycling and 5 Ohm 50W test load in J5

6. Check operation of SENSOR-ENBL and measure 5V (TP7) value and noise.

7. Check operation of TPU6 (U14.C27) and voltage on U18.A10

Sensors
8. External pressure sensor. Check voltages on J6.3, J6.2, and TP10

9. Internal Pressure sensor. Check voltages on U6.1, U6.2, TP11

10. Temperature sensor. Check voltage on U10.1 (3.3V) and TP15

11. Humidity sensor. Check voltage on U11.3 (3.3V) and TP14.

Plug test Persistor board and run AD Test.
Record values on channels:

0:

1:

2:

3:

4:

5:

Monterey Bay Aquarium Research Institute
7700 Sandholdt Rd, Moss landing CA 95076

Engineer
Klimov 831-775-1914

Page Title
BEDS Mother Board / Checklist

Project: *see page 1*

Size: B | Document Number: *see page 1* | File Name (auto): *10020895-MOB3* | Rev: *see page 1*

Page Modify Date (auto): *Thursday, February 22, 2018*
Design Modify Date (auto): *Thursday, February 22, 2018*
Sheet: 4 of 4

Full path (auto):
U:\ORCAD PROJECTS\BEDS\10020895-MOB3\10020895-MOB3.DSN

Group16

PPS/GPS: 5V 100ms active high
PPS/Clock: 3.3V 400us active high
5nS low pass filter

R38
1M/0603

J9
ConnRF/SMA

R39 100/0603

D13
BZT52C10-7-F/SOD-123

R40
1k/0603

Q5
BSS138-7-F/SOT-23

S2 PBM

GND

S1 WAKE

GND

Group15

Persistor Board

U14C

C50	IRQ3/CTS	RSCTS	C49
C48	/RTS	RSRTS	C47
C46	/TXD	/RXD	C45
C44	RSTXD	RSRXD	C43
C42	MODLCK	/IRQ2	C41
C40	/IRQ7	/IRQ5	C39
C38	/WAKE	TPU15	C37
C36	XCLK	TPU14	C35
C34	TPU13	TPU12	C33
C32	TPU11	TPU10	C31
C30	TPU9	TPU8	C29
C28	TPU7	TPU6	C27
C26	TPU5	TPU4	C25
C24	TPU3	TPU2	C23
C22	TPU1	/PSC0	C21
C20	MISO	/PCS1	C19
C18	MOSI	/PCS3	C17
C16	/SCK	/PCS2	C15
C14	VBBK	VBAT	C13
C12	/SHDN	VLIN	C11
C10	DSO	VREG	C9
C8	DSI	/RESET	C7
C6	FREEZE	VBAK	C5
C4	/BKPT	GND	C3
C2	/BERR	/DS	C1

Persistor-CF2/Conn25x2

R48 100/0603

J13
TE/0.1/3x1

MOB1 to MOB2 revision:
J11: BU2032-1-ND-G added
R60: 100/0603 added
J13: TE 0.1/3x1 added
J14, R61,R62,R63,R64,R65,U21 added

Rev2 (cont. from Page2): Install J11 (BU2032)
instead of J10 (Keystone/3003)

R60
100/0603

TP20
VBBK

Pull-Up resistors
from page 3

R51 1M/0603
R50 1M/0603
R37 1M/0603
R41 1M/0603

R46
1M/0603

R47
1M/0603

R53
1M/0603

Pull-Up resistors
from page 2

R21 1M/0603

MPU-6050 With Power Enable

Group17

+3.3V

R43 2M/0603

R44 1k/0603

U15A
FDS4897AC/SO-8

U15B
FDS4897AC/SO-8

R45 2M/0603

GND

Pull-down resistors
from page 3

R42
1M/0603

GND

Pull-down resistors
from page 2

R36
1M/0603

Title	<Title>	
Size B	Document Number <Doc>	Rev <RevCode>
Date: Thursday, February 22, 2018	Sheet 5 of 5	