5/6/2005

DATA CONTROL RELEASE VERIFICATION

REVISIONS				
REV	ECO	DESCRIPTION	DATE	APPROVED
AJ	513090	REPLACES REV. AJ WITHOUT CHANGE. KM	5/5/05	KM

SOURCE CONTROL DRAWING

THIS IS A COMPUTER GENERATED DOCUMENT.
ALL SHEET REVISIONS ARE IDENTICAL TO REVISION BLOCK ENTRY.

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TITLE

LN-200 INERTIAL MEASUREMENT UNIT

SIZE	CAGE CODE	NUMBER	REV
A	06481	311875	AJ

SCALE | SHEET 1 of 50

FORM SW28-237 (3/01)

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LIST OF TABLES

1. SCOPE

THIS SPECIFICATION DESCRIBES THE PERFORMANCE, DESIGN, MANUFACTURE AND ACCEPTANCE TEST OF THE LN-200 INERTIAL MEASUREMENT UNIT (IMU). THE LN-200 IMU IS IN PRODUCTION AND IS A NON-DEVELOPMENT ITEM (NDI).

SEVERAL IMU PERFORMANCE AND OPERATION VERSIONS ARE AVAILABLE AND ARE DESCRIBED IN THIS SPECIFICATION. SEE SECTION 6.

2. APPLICABLE DOCUMENTS

THE FOLLOWING DOCUMENTS OF THE EXACT ISSUE SHOWN FORM A PART OF THIS DOCUMENT TO THE EXTENT SPECIFIED. IN THE EVENT OF CONFLICT BETWEEN THIS DOCUMENT AND THE DOCUMENTS REFERENCED HEREIN, THE CONTENTS OF THIS DOCUMENT TAKE PRECEDENCE.

2.1 GOVERNMENT DOCUMENTS

SPECIFICATIONS

MILITARY

DoD-D-1000B ATTACHMENT 4 NOTICE 1 1 JULY 1990	DRAWINGS, ENGINEERING AND ASSOCIATED LISTS
MIL-B-5087B AMENDMENT 3 24 DEC 1984	BONDING, ELECTRICAL AND LIGHTNING PROTECTION, FOR AEROSPACE SYSTEMS
MIL-C-5541E 30 NOV 90	CHEMICAL CONVERSION COATINGS ON ALUMINUM AND ALUMINUM ALLOYS
MIL-HDBK-5400 30 NOV 1995	ELECTRONIC EQUIPMENT, AIRBORNE, GENERAL GUIDELINES FOR
MIL-E-6051D NOTICE 1 26 FEB 1988	ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS, SYSTEMS
MIL-F-7179G 14 APR 1993	FINISHES, COATINGS, AND SEALANTS FOR THE PROTECTION OF AEROSPACE WEAPONS SYSTEMS
MIL-Q-9858A NOTICE 1 23 JUL 1993	QUALITY PROGRAM REQUIREMENTS

FEDERAL

QQ-N-290A 12 NOV 1971	NICKEL PLATING

STANDARDS

MILITARY

DOD-STD-2167A 29 FEB 1988	DEFENSE SYSTEM SOFTWARE DEVELOPMENT
MIL-STD-129M 15 JUN 1993	MARKING FOR SHIPMENT AND STORAGE
MIL-STD-130H 1 DEC 1993	U.S. MILITARY PROPERTY, IDENTIFICATION MARKING OF
MIL-HDBK-454 28 APR 1995	ELECTRONIC EQUIPMENT, GENERAL GUIDELINES FOR
MIL-STD-461D 11 JAN 1993	CONTROL OF ELECTROMAGNETIC INTERFERENCE EMISSIONS AND SUSCEPTIBILITY, REQUIREMENTS FOR
MIL-STD-462D NOTICE 3 5 FEB 1996	MEASUREMENT OF ELECTROMAGNETIC INTERFERENCE CHARACTERISTICS, TEST METHOD STANDARD FOR
MIL-STD-810E NOTICE 3 31 JULY 1995	ENVIRONMENTAL TEST METHODS AND ENGINEERING GUIDELINES
MIL-STD-882C NOTICE 1 19 JAN 1996	SYSTEM SAFETY PROGRAM REQUIREMENTS
MIL-STD-1385B 1 AUG 1986	PRECLUSION OF ORDNANCE HAZARDS IN ELECTROMAGNETIC FIELDS, GENERAL REQUIREMENTS FOR
MIL-STD-1472D NOTICE 3 10 FEB 1994	HUMAN ENGINEERING DESIGN CRITERIA FOR MILITARY SYSTEMS, EQUIPMENT AND FACILITIES
MIL-STD-1686C 25 OCT 1995	ELECTROSTATIC DISCHARGE CONTROL PROGRAM FOR PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS, ASSEMBLIES AND EQUIPMENT

HANDBOOKS

MIL-HDBK-217F NOTICE 2 28 FEB 1995	RELIABILITY PREDICTION OF ELECTRONIC EQUIPMENT

2.2 NON–GOVERNMENT DOCUMENTS

EIA

EIA RS-422	STANDARD FOR ELECTRICAL CHARACTERISTICS OF BALANCED VOLTAGE DIGITAL INTERFACE CIRCUITS
EIA RS-485 APRIL 1983	STANDARD FOR ELECTRICAL CHARACTERISTICS OF GENERATORS AND RECEIVERS FOR USE IN BALANCED DIGITAL MULTIPOINT SYSTEMS

IBM

GA27-3093-2 MARCH 1979	IBM SYNCHRONOUS DATA LINK CONTROL, GENERAL INFORMATION

LITTON

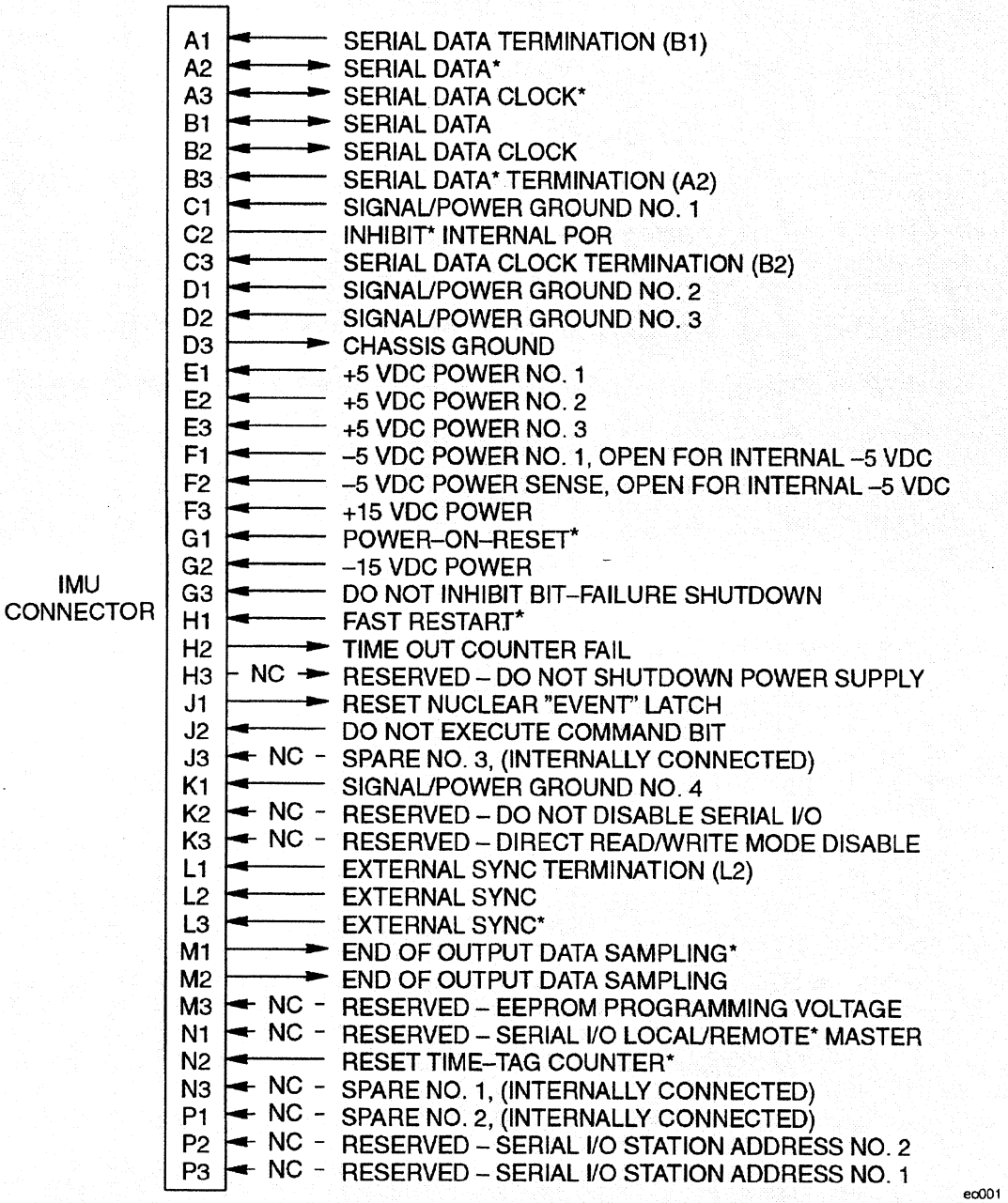
408600 22 OCT 1996	LN-200 HIGH RELIABILITY INDUSTRIAL PARTS PROGRAM CONTROL PLAN
LPS 990012 REVISION V 28 MAR 1996	PACKAGING AND MARKING OF ASSEMBLIES, SUBASSEMBLIES AND COMPONENTS FOR SHIPMENT
LPS 990026 REVISION R 9 APR 1996	HANDLING AND PROTECTION OF EQUIPMENT, INTRAFACILITY
LPS 990142 REVISION F 16 FEB 1996	BURRS AND SHARP EDGES, REQUIREMENTS FOR
LPS 992055 REVISION H 25 MAR 1996	SOLDERING

3. REQUIREMENTS

3.1 ITEM DEFINITION. THE LN-200 INERTIAL MEASUREMENT UNIT (IMU) IS AN ALL–ATTITUDE STRAPDOWN UNIT THAT MEASURES VELOCITY AND ANGLE CHANGES IN A COORDINATE SYSTEM FIXED RELATIVE TO ITS CASE. DIGITAL OUTPUT DATA OF INCREMENTAL VELOCITY AND INCREMENTAL ANGLE ARE PROVIDED TO USER EQUIPMENT.

THE IMU USES A TRIAD OF FIBER OPTIC GYROSCOPES AND THREE SILICON ACCELEROMETERS.

3.1.1 FUNCTIONAL INTERFACES. FUNCTIONAL INTERFACES FOR THE IMU CONSIST OF AN ELECTRICAL SIGNAL AND POWER INTERFACE AS SHOWN IN FIGURE 1 AND A MECHANICAL INTERFACE AS SHOWN IN FIGURE 3.



"NC" RESERVED – USED FOR TEST MODE ONLY; NOT AVAILABLE FOR CUSTOMER USE.
"NC" SPARES – INTERNALLY CONNECTED, BUT ARE AVAILABLE FOR USE.
SIGNAL LINE TERMINATION CAN BE ACTIVATED BY EXTERNAL CABLE CONNECTION TO APPROPRIATE PIN IN PARENTHESES.

FIGURE 1. ELECTRICAL SIGNAL & POWER INTERFACE

PINS A1, B3, C3, AND L1 ARE NOT USED IF A2/B1, A3/B2, AND L2/L3 (IF USED) HAVE A BALANCED TERMINATION AT THE RECEIVING END. **SEE SECTION 6.2C**

PINS A2/B1, A3/B2, L2/L3, AND M1/M2 SHOULD BE TWISTED, SHIELDED PAIRS.

PINS C1, D1, D2, AND K1 ARE SIGNAL/POWER GROUNDS CONNECTED INTERNALLY IN THE IMU. TOTAL GROUND CURRENT IS ABOUT 4 AMPS MAXIMUM SPLIT AMONG THE FOUR GROUND LINES.

PIN D3 IS CHASSIS GROUND AND IS NOT CONNECTED TO SIGNAL/POWER GROUND IN THE IMU. THE IMU USER SHOULD CONNECT THIS GROUND TO SIGNAL/POWER GROUND AT THE MAIN POWER SUPPLY.

PINS E1, E2, AND E3 ARE +5 V DC POWER LINES AND MUST CARRY UP TO 2.4 AMPS. THE ±5% TOLERANCE MUST BE MAINTAINED AT THE IMU CONNECTOR PINS AT ALL POWER LEVELS.

PIN F1 IS THE EXTERNAL -5 V DC POWER LINE AND MUST CARRY UP TO 0.7 AMP IF EXTERNAL -5 V DC IS USED. PIN F2 IS THE EXTERNAL -5 V DC SENSE LINE AND MUST BE CONNECTED TO -5 V DC IF EXTERNAL -5 V DC IS USED. **IF F1 IS CONNECTED TO -5V DC AND F2 IS OPEN, IMU DAMAGE MAY OCCUR**. BOTH PINS F1 AND F2 ARE OPEN OR NC FOR INTERNAL -5 V DC.

PIN F3 IS +15 V DC AND CARRIES 0.2 AMPS STEADY STATE. THE ±5% TOLERANCE MUST BE MAINTAINED AT THE IMU CONNECTOR PINS AT ALL POWER LEVELS.

PIN G2 IS -15 V DC AND CARRIES UP TO 0.3 AMPS. THE ±5% TOLERANCE MUST BE MAINTAINED AT THE IMU CONNECTOR PINS AT ALL POWER LEVELS.

PINS C2, G1, G3, H1, H2, H3, J1, J2, L2/L3, M1/M2, AN N2 ARE COVERED BY SEPARATE PARAGRAPHS.

PINS J3, K2, K3, M3, N1, N3, P1, P2, AND P3 ARE NOT USED BY THE IMU USER.

SEE 6.6 FOR OPTION C = 1, AMRAAM INTERFACE, CONNECTOR CROSS REFERENCE.

3.1.1.1 ELECTRICAL SIGNAL INTERFACE. THE LN-200 UNIT PROVIDES ELECTRICAL SIGNAL INTERFACE BY AN RS-485 SERIAL DIGITAL DATA BUS AND INTERFACE DISCRETE LINES. THE DATA BUS PROTOCOL IS THE IBM SYNCHRONOUS DATA LINK CONTROL (SDLC) GA27-3093-2 WITH LSB TRANSMITTED FIRST. THE PRIMARY MODE OF OPERATION USES A SIMPLIFIED VERSION OF SDLC WITH THE IMU IN A BROADCAST MODE AND THE "ADDRESS" OR "CONTROL" DATA BYTES ARE ABSENT IN THE MESSAGES FROM THE IMU. IN THIS MODE THE IMU IS THE BUS STATION MASTER AND INITIATES COMMUNICATIONS WITH USER EQUIPMENT BY SENDING SERIAL DATA. THE IMU DATA IS SAMPLED AT A RATE OF 400 HZ AND TRANSMITTED ON THE FALLING EDGE OF AN INTERNALLY GENERATED 1.0152 MHZ DATA CLOCK. USERS SHOULD SAMPLE THE SERIAL DATA ON THE RISING EDGE OF THE SERIAL DATA CLOCK. TRANSMISSION OF UPDATED IMU DATA IS COMPLETED WITHIN 1.0 MS OF IMU DATA SAMPLING. THE LN-200 HAS THE FLEXIBILITY TO ACCOMMODATE OTHER DATA FREQUENCIES (10, 80, 100, 200, 400, AND 2000 Hz), OTHER DATA CLOCK FREQUENCIES (2.0304 AND 4.0608 MHz), USE OF EXTERNAL

DATA CLOCK (F_{LOWER} > MESSAGE BIT RATE, F_{UPPER} < 2 MHz), AN EXTERNAL SYNCHRONIZATION SIGNAL (100 Hz), DIFFERENT MESSAGE CONTENT, AND DIFFERENT DATA SCALING. THESE **FACTORY SET** OPTIONS ARE SHOWN IN SECTION 6.3.

FIGURE 2 DEPICTS THE MESSAGE FRAME STRUCTURE. IT CONSISTS OF A ONE–BYTE OPENING OR BEGINNING FLAG, THE INFORMATION FIELD WITH CAPACITY OF 26 DATA BYTES (THIRTEEN 16–BIT WORDS), A TWO–BYTE FRAME CHECK SEQUENCE, AND A ONE–BYTE CLOSING OR ENDING FLAG. BETWEEN DATA FRAMES, THE DATA BUS LINES ARE TRI-STATE AND NO DATA ARE TRANSMITTED. WHEN THE TRANSMITTER IS TRI-STATED, THE LINE TERMINATION PULL-UPS CAUSE THE RECEIVER TO READ ALL 1'S. THIS IS THE SDLC IDLE COMMAND. THE RECEIVER ABORTS THE CURRENT MESSAGE AND PREPARES FOR A NEW MESSAGE. SEE PARAGRAPH 6.2.C FOR ADDITIONAL INFORMATION.

THE OPENING AND CLOSING FLAGS ARE USED TO ALLOW MESSAGES TO BE OF VARIABLE LENGTH. IN ORDER TO MAINTAIN THE UNIQUE FLAG BYTE PATTERN OF A ZERO, SIX ONES AND A ZERO, THE CONTENTS OF THE REST OF THE FRAME ARE CONSTRAINED TO FIVE CONTIGUOUS ONES BY ARTIFICIALLY INSERTING ZEROS (ZERO BIT INSERTION) BEFORE TRANSMITTING. THESE ZERO BITS WILL BE REMOVED BY THE USER STATION EQUIPMENT AFTER RECEPTION.

THE FRAME CHECK SEQUENCE (FCS) FIELD ALLOWS THE USER STATION TO CHECK THE TRANSMISSION ACCURACY OF THE FRAME. THIS SEQUENCE IS A 16–BIT CYCLIC REDUNDANCY CODE AS DEFINED BY SDLC PROTOCOL. THE INFORMATION FIELD DATA IS SELECTED BY SOFTWARE WITH A DEFAULT 400 Hz PARAMETER LIST AS SHOWN IN TABLE I.

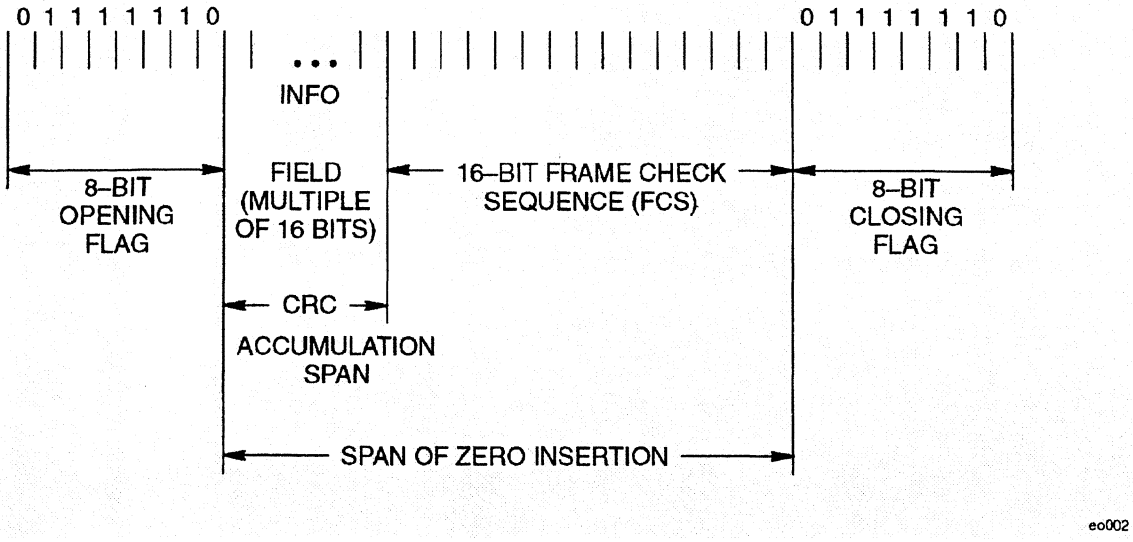


FIGURE 2. SIMPLIFIED SDLC IMU TRANSMISSION FRAME

TABLE I. LN-200 IMU OUTPUT MESSAGE CONTENTS
-DEFAULT LIST-

MESSAGE CONTENTS: (16–BIT WORDS)

WORD NO.	CONTENTS	UNITS & SCALING
1	X DELTA–VELOCITY	METERS/SEC B1.14
2	Y DELTA–VELOCITY	METERS/SEC B1.14
3	Z DELTA–VELOCITY	METERS/SEC B1.14
4	X DELTA–ANGLE	RADIANS B–4.19
5	Y DELTA–ANGLE	RADIANS B–4.19
6	Z DELTA–ANGLE	RADIANS B–4.19
7	IMU STATUS SUMMARY WORD	N/A
8	MODE BIT/MUX ID	(8 LSB'S = MUX ID)
9	MULTIPLEXED DATA WORD	SEE BELOW
10	X RAW GYRO COUNTS	PULSES B15.0
11	Y RAW GYRO COUNTS	PULSES B15.0
12	Z RAW GYRO COUNTS	PULSES B15.0
13	CHECK SUM	ONES COMPLEMENT SUM OF WORDS 1–12

MULTIPLEXED DATA WORD CONTENTS:

MUX COUNT	WORD CONTENTS	UNITS & SCALING
0	X GYRO TEMPERATURE	°C B7.8
1	Y GYRO TEMPERATURE	°C B7.8
2	Z GYRO TEMPERATURE	°C B7.8
3	X ACCEL TEMPERATURE	°C B7.8
4	Y ACCEL TEMPERATURE	°C B7.8
5	Z ACCEL TEMPERATURE	°C B7.8
6	LASER DIODE TEMPERATURE	°C B7.8
7	OPTICAL RECEIVER TEMPERATURE	°C B7.8
8	BFS TEMPERATURE	°C B7.8
9	-5 V DC MONITOR	7 V DC B0.15
10	+5 V DC MONITOR	7 V DC B0.15
11	-15 V DC MONITOR	20 V DC B0.15
12	+15 V DC MONITOR	20 V DC B0.15
13	ANALOG GROUND	3 V DC B0.15
14	IMU DETAILED FAILURE #0	N/A
15	IMU DETAILED FAILURE #1	N/A
16	IMU DETAILED FAILURE #2A	N/A
17	IMU DETAILED FAILURE #3	N/A

MUX COUNT	WORD CONTENTS	UNITS & SCALING
29	IMU DETAILED FAILURE #15	N/A
30	IMU DETAILED FAILURE #2B	N/A
31	A/D SAT COUNTER X	CNT, B 15.0
32	A/D SAT COUNTER Y	CNT, B 15.0
33	A/D SAT COUNTER Z	CNT, B 15.0

LN-200 IMU STATUS SUMMARY WORD

BIT	FAILURE
(LSB) 0	DELTA VELOCITY COUNTER
1	D/A CONVERTER
2	GYRO
3	ACCELEROMETER
4	GYRO LOOP CONTROLLER
5	GYRO TEMPERATURE
6	ACCELEROMETER TEMPERATURE
7	POWER SUPPLY VOLTAGE
8	A/D CONVERTER
9	SERIAL I/O
10	CPU OR MEMORY
11	LASER DIODE
12	TEC
13	BFS FIBER TEMPERATURE
14	OPTICAL RECEIVER
(MSB) 15	RESERVED

LN-200 MODE BIT/MUX ID WORD

BIT	DESCRIPTION
0 - 7	MULTIPLEXED DATA WORD ID
8	GYRO ACCURACY IS DEGRADED
9	GYRO IS DISABLED
10	SHUTDOWN ON FAILURE INHIBITED
11	FAST START
12	COMMANDED BIT IN PROGRESS
13	RESERVED FOR EXTERNAL SYNC OPTION (SYNCHRONIZED)
14	ACCELEROMETER DATA ARE INVALID
15	SPARE

THE SCALING CONVENTION IN TABLE I USES THE FOLLOWING NOTATION:

BX.Y

WHERE:

B = BINARY SCALING.

X = THE NUMBER OF DATA BITS (LESS SIGN BIT) TO THE LEFT OF THE BINARY POINT. IF X < 0, THEN THE BINARY POINT IS X IMAGINARY BITS TO THE LEFT OF THE MOST SIGNIFICANT STORAGE BIT.

Y = THE NUMBER OF DATA BITS TO THE RIGHT OF THE BINARY POINT. IF Y < 0, THEN THE BINARY POINT IS Y IMAGINARY BITS TO THE RIGHT OF THE LEAST SIGNIFICANT STORAGE BIT.

THE FOLLOWING INFORMATION CAN BE DERIVED FROM THIS NOTATION:

MAXIMUM VALUE	= +2**(X) - 1 LSB
MINIMUM VALUE	= -2**(X)
RESOLUTION	= 2**(-Y)
WORD SIZE	= X + Y + 1

THE X, Y, AND Z DELTA-VELOCITY SCALING IS B1.14 METERS/SEC OR 1/16384 M/S (2^{-14}), AND THE WEIGHT OF THE SIGN BIT IS -2^1 OR -2.

THE X, Y, AND Z DELTA-ANGLE SCALING IS B-4.19 RADIANS OR 1/524288 RADIANS (2^{-19}). THE WEIGHT OF THIS SIGN BIT IS -2^{-4} OR -1/16.

NOTE: THE DATA IN WORDS 10,11, AND 12 ARE RAW GYRO PULSE COUNTS AND SHOULD NOT BE USED. THE MULTIPLEXED DATA WORD IS USED FOR SYSTEM TEST AND IS NOT NORMALLY USED IN IMU APPLICATIONS.

AS AN OPTION, WORDS 10, 11, AND 12 MAY BE FILTERED ANGULAR RATES SCALED AT RAD/SEC, B5.10. THE FILTER IS A SECOND ORDER LOW PASS OPERATING AT 2000 Hz WITH A NATURAL FREQUENCY OF 100 Hz AND A DAMPING FACTOR OF 0.7.

AS ANOTHER OPTION, THE OUTPUT MESSAGE MAY BE REDUCED FROM 13 WORDS TO 10 WORDS. THE DATA IN WORDS 10-12 IS NOT SENT AND WORD 10 IS THE CHECK SUM.

THE 2000 Hz OUTPUT DATA RATE VERSION TRANSMITS 4 WORDS. GYRO DATA ARE IN WORDS 1-3 AND WORD 4 IS THE CHECK SUM.

SEE SECTION 6.3. LN-200 OPTIONS

TABLE II PROVIDES A SUMMARY OF THE OUTPUT DETAILS FOR DIFFERENT OUTPUT DATA RATES

TABLE II. OUTPUT DATA RATES

GYRO				
RATE, Hz	SCALING/UNITS, rad	LSB, rad	RANGE, °/s	RESOLUTION, °/Hr
2000	B-7.22	1/4194304	895	98
400	B-4.19	1/524288	1432	157
200	B-3.18	1/262144	1432	157
100	B-2.17	1/131072	1432	157
80	B-2.17	1/131072	1146	125.9
10	B-4.19	1/524288	35.8	3.9
ACCELERATION				
RATE, Hz	SCALING/UNITS, m/s	LSB, m/s	RANGE, g	RESOLUTION, m/s^2
2000	N/A	N/A	N/A	N/A
400	B1.14	1/16384	81.6	0.024
200	B1.14	1/16384	40.8	0.012
100	B2.13	1/8192	40.8	0.012
80	B3.12	1/4096	65.3	0.0195
10	B1.14	1/16384	2.08	0.00061

THESE ARE THE DEFAULT VALUES. FOR OTHER OUTPUT DATA SCALING OPTIONS. SEE 6.3.F

3.1.1.1.1 DISCRETE INPUTS AND OUTPUTS. INPUT DISCRETE AND OUTPUT DISCRETE SIGNALS ARE PROVIDED AS LISTED IN TABLE III AND DESCRIBED IN THE PARAGRAPHS THAT FOLLOW. FOR INPUT DISCRETES, LOGIC LOW IS GROUND AND LOGIC HIGH IS OPEN. WHEN OPEN, THE LINE IS PULLED UP TO +5 V DC IN THE IMU.

3.1.1.1.1.1 POWER–ON–RESET* INPUT DISCRETE. THE LN-200 HAS AN INTERNAL POWER-ON-RESET THAT INHIBITS IMU OPERATION UNTIL THE INPUT VOLTAGES HAVE STABILIZED AND ARE WITHIN SPECIFICATION.

THE POWER-ON-RESET INPUT DISCRETE WILL OVERRIDE THE INTERNAL POR. IF IT IS USED, IT SHALL BE A LOGIC LOW UNTIL AT LEAST 10 MILLISECONDS AFTER THE LAST SUPPLY HAS RISEN TO WITHIN ITS TOLERANCE; THEN THE DISCRETE SHALL TRANSITION TO A LOGIC HIGH TO ALLOW NORMAL OPERATION. THE DISCRETE SHALL RETURN TO A LOGIC LOW IF ANY SUPPLY GOES OUT OF TOLERANCE. POWER ON RESET* IS ON PIN G1. THE IMU IS IN RESET IF EXTERNAL POR IS LOW OR INTERNAL POR IS LOW (INPUT VOLTAGE OUT OF SPECIFICATION).

3.1.1.1.1.2 DO NOT EXECUTE COMMANDED BIT INPUT DISCRETE. THIS DISCRETE ALLOWS THE USER EQUIPMENT TO REQUEST THE IMU TO EXECUTE INTERNAL SELF TEST. A GROUND OR A LOGIC LOW ACTIVATES THE EXECUTION OF THE BIT SOFTWARE.
NOTE: OUTPUT DATA ARE NOT VALID DURING COMMANDED BIT.

3.1.1.1.1.3 DO NOT INHIBIT BIT FAILURE SHUTDOWN INPUT DISCRETE. IMU–DETECTED FAILURES THAT HAVE POTENTIAL FOR PERMANENT DAMAGE TO THE IMU INITIATE AN IMU SHUTDOWN SEQUENCE. THIS DISCRETE WHEN GROUNDED, OR A LOGIC LOW, INHIBITS THE IMU FROM SHUTDOWN. FAILURES ARE REPORTED IN IMU STATUS, WORD NO. 7.

3.1.1.1.1.4 FAST RESTART. IF THE INPUT POWER TO THE IMU IS INTERRUPTED, THIS DISCRETE MAY BE USED TOGETHER WITH POWER–ON–RESET (POR) TO BYPASS TURN–ON BIT AND REDUCE THE RESTART TIME TO LESS THAN 125 MS. FOR FAST RESTART, THIS INPUT DISCRETE IS SET TO A LOGIC LOW WHEN POR IS APPLIED AND IS LATCHED OR REMAINS LOW FOR AT LEAST 20 MS AFTER POR IS REMOVED. THIS DISCRETE WOULD BE USED FOR IMU RESTART AFTER A NUCLEAR EVENT. FAST RESTART IS ON PIN H1.

3.1.1.1.1.5 RESET TIME–TAG COUNTER INPUT DISCRETE (OPTIONAL). THIS INPUT DISCRETE RESETS THE TIME–TAG COUNTER WHEN THE DISCRETE CHANGES FROM A LOGIC HIGH TO A LOGIC LOW (FALLING EDGE) AND REMAINS LOW FOR GREATER THAN 200 NANOSECONDS. THE TIME–TAG COUNTER IS A 16–BIT COUNTER WITH A 15,618.462 HZ INPUT CLOCK. THE CONTENTS OF THE COUNTER MAY BE READ WHEN INCREMENTAL ANGLE AND INCREMENTAL VELOCITY DATA ARE SAMPLED AND MAY BE TRANSMITTED (64 µSEC/LSB) AS PART OF THE OUTPUT MESSAGE ON THE SDLC SERIAL DATA BUS. **THIS OPTION IS NOT AVAILABLE IN THE LN-200 SOFWARE AT THIS TIME.**

TABLE III. DISCRETE INPUTS AND OUTPUTS

SIGNAL	TYPE
POWER–ON–RESET*	INPUT
DO NOT EXECUTE COMMANDED BIT	INPUT
DO NOT INHIBIT BIT FAILURE SHUTDOWN	INPUT
FAST RESTART	INPUT
INHIBIT* INTERNAL POR	INPUT
RESET TIME–TAG COUNTER	NOT AVAILABLE
RESET NUCLEAR EVENT LATCH	NOT AVAILABLE
TIME OUT COUNTER FAIL	OUTPUT
DO NOT SHUTDOWN POWER SUPPLY	OUTPUT (RESERVED, NC)
DIRECT READ/WRITE MODE DISABLE	INPUT (RESERVED, TEST ONLY)
SERIAL I/O LOCAL/REMOTE* MASTER	INPUT (RESERVED, TEST ONLY)
SERIAL I/O STATION ADDRESS LSB 1	INPUT (RESERVED, TEST ONLY)
SERIAL I/O STATION ADDRESS LSB 2	INPUT (RESERVED, TEST ONLY)
SERIAL I/O STATION ADDRESS LSB 3	INPUT (RESERVED, TEST ONLY)
SERIAL I/O STATION ADDRESS MSB	INPUT (RESERVED, TEST ONLY)
DO NOT DISABLE SERIAL I/O	INPUT (RESERVED, TEST ONLY)

3.1.1.1.1.6 RESET NUCLEAR EVENT LATCH OUTPUT DISCRETE. **NOT USED**

3.1.1.1.1.7 DISCRETES FOR FACTORY TEST MODE ONLY. DISCRETE INPUTS THAT ALLOW CONTROL/CONFIGURATION OF THE IMU IN A FACTORY TEST ENVIRONMENT ARE ALLOCATED AT THE IMU CONNECTOR (NO SEPARATE TEST CONNECTOR) WITH THE UNDERSTANDING THAT THE OPERATIONAL EXTERNAL CABLE WILL HAVE NO CONNECTION ON THOSE INPUT PINS.

3.1.1.1.1.8 TIME OUT COUNTER. TIME OUT COUNTER (TOC) FAIL INDICATES THAT ALL OF THE FOREGROUND SOFTWARE TASKS ARE NOT BEING COMPLETED. THE COUNTER TIMES–OUT IN 1.28 SECONDS. THE RESET OCCURS AT A 1 HZ RATE. WHEN A FAILURE OCCURS, PIN H2 SWITCHES FROM GROUND TO HIGH, AND THE LASER DIODE MODULE IS DISABLED. IF SHUTDOWN–INHIBIT, PIN G3, HAS BEEN GROUNDED, THE LASER DIODE MODULE IS NOT DISABLED AND ONLY THE TOC DISCRETE IS SET. THIS SIGNAL IS DELETED WHEN H2 IS USED FOR THE DIFFERENTIAL POWER ON RESET INPUT.

3.1.1.1.1.9 INHIBIT* INTERNAL POWER-ON-RESET. A LOGIC LOW ON PIN C2 WILL INHIBIT THE OPERATION OF THE INTERNAL POR.

3.1.1.1.2 OTHER SIGNALS

A.	SERIAL DATA CLOCK	OUTPUT (OR INPUT)
B.	END OF OUTPUT DATA SAMPLING	OUTPUT (RS-485)
C.	EXTERNAL SYNCHRONIZATION SIGNAL	INPUT (RS-485)
D.	EEPROM PROGRAMMING VOLTAGE	INPUT (RESERVED, TEST ONLY)
E.	TERMINATION/BIASING	

3.1.1.1.2.1 SERIAL DATA CLOCK. THE SERIAL DATA CLOCK IS INTERNALLY GENERATED AT 1.0152 MHZ AND 50% ±10% DUTY CYCLE. THE OUTPUT IS RS-485. CAPABILITY IS ALSO INCLUDED IN THE IMU TO SELECT AN EXTERNAL DATA CLOCK (F_{LOWER} > MESSAGE BIT RATE, F_{UPPER} < 2mHz) GENERATED BY THE USER.

3.1.1.1.2.2 END OF OUTPUT DATA SAMPLING. RS-485, TRUE, FALSE FOR >8.0 µSEC, THEN TRUE AGAIN. THE FALLING EDGE IS COINCIDENT WITH THE INTERNAL LATCHING OF DATA TO BE OUTPUT ON THE DIGITAL DATA BUS.

3.1.1.1.2.3 EXTERNAL 100 HZ SYNCHRONIZATION SIGNAL **(FACTORY SET OPTION)**. RS-485, FALSE FOR >21 µSEC, TRUE FOR >21µSEC, 100Hz. THE IMU PHASE LOCKS TO THIS SIGNAL AND ADJUSTS ITS INTERNAL DATA LATCHING FREQUENCY TO BE IN PHASE WITH THE RISING EDGE OF THIS EXTERNAL SYNC SIGNAL TO AN ACCURACY OF 125µSEC. THE TIME AT WHICH INTERNAL DATA IS LATCHED IS CHANGED IN 55µSEC STEPS UNTIL THE DATA LATCH OCCURS AT THE SAME TIME AS THE RISING EDGE OF THE INPUT DATA SYNC PULSE. INSTRUMENT PERFORMANCE DOES NOT CHANGE WITH THE USE OF EXTERNAL SYNC. THE EXTERNAL SYNCHRONIZATION SIGNAL MUST BE PRESENT WITHIN 40 MS AFTER ALL POWER IS WITHIN SPECIFICATION, AND MUST BE **100HZ ± 0.4HZ** IN ORDER TO MAINTAIN SYNC. THE SMALLER THE DIFFERENCE BETWEEN THE LN-200 CLOCK AND THE EXTERNAL SYNC INPUT THE LESS THE OUTPUT DATA JITTER.

THE LN-200 DEFAULT CONDITION IS NO EXTERNAL SYNCHRONIZATION INPUT.

3.1.1.1.2.4 EEPROM PROGRAMMING VOLTAGE. THIS INPUT VOLTAGE IS TO BE USED IN THE TEST MODE ONLY IN CONJUNCTION WITH THE DIRECT READ/WRITE INPUT DISCRETE AND WILL ALLOW PROGRAMMING THE EEPROM FIRMWARE AND SENSOR CALIBRATION PARAMETERS.

3.1.1.1.2.5 LINE TERMINATION AND BIASING. THE IMU CONTAINS THE CAPABILITY OF TERMINATING AND BIASING THE SERIAL DATA BUS BY CONTACT CLOSURES ACROSS PINS AT THE EXTERNAL CONNECTOR, IF REQUIRED.

3.1.1.2 ELECTRICAL POWER INTERFACE. THE IMU REQUIRES REGULATED DC VOLTAGES OF +5 VOLTS, -5 VOLTS, +15 VOLTS AND -15 VOLTS WITH TYPICAL CHARACTERISTICS SHOWN IN TABLE IV. THE LN-200 IMU WILL TURN-ON IF THE POWER SUPPLY HAS THE MINIMUM OUTPUT CURRENT AND THE INPUT CAPACITANCE DRIVE CAPABILITIES SHOWN IN TABLE IV. IMU POWER BUDGET AS A FUNCTION OF TEMPERATURE IS AS SHOWN IN TABLE V. **NOTE: VOLTAGE TOLERANCE MUST BE MAINTAINED AT THE IMU CONNECTOR**

TABLE IV. INPUT POWER CHARACTERISTICS

EXTERNAL -5 V DC

INPUT VOLTAGE V DC	TOLERANCE %	RIPPLE MV P-P	LOAD CURRENT	
			START MA	STEADY STATE MA
+5	±5	150	2400	1600
-5	±5	150	700	700
+15	±5	300	150	150
-15	±5	300	40	40

INTERNAL -5 V DC

INPUT VOLTAGE V DC	TOLERANCE %	RIPPLE MV P-P	START MA	STEADY STATE MA
+5	±5	150	2400	1600
+15	±5	300	150	150
-15	±5	300	280	280

MINIMUM POWER SUPPLY CAPABILITIES AND INRUSH CURRENT

VOLTAGE, VDC	POWER SUPPLY MINIMUM CURRENT, AMPS	LN-200 CAPACITANCE, µF
+5	2.5	200
+15	0.3	16
-15	0.35	21
-5, IF USED	1.0	21

TABLE V. IMU POWER BUDGET

OPERATING TEMPERATURE	RUN POWER (W)
-55 °C	15
25 °C	12
85 °C	15

3.1.1.3 MECHANICAL INTERFACE. THE IMU SHALL BE MOUNTED DIRECTLY TO THE VEHICLE STRUCTURE OR EMBEDDED WITHIN THE STRUCTURE OF ANOTHER UNIT BY MEANS OF FOUR MOUNTING BOLTS. TO ENSURE CORRECT ORIENTATION RELATIVE TO THE VEHICLE AXES AND CORRECT SIGN CONVENTIONS FOR THE IMU PARAMETERS THAT ARE OUTPUT ON THE SDLC SERIAL DATA BUS, TWO PRECISION GROUND, STEEL ALIGNMENT BUSHINGS SHALL BE ASYMMETRICALLY SITUATED ON THE IMU BOTTOM MOUNTING SURFACE. POSITIVE X, Y, AND Z DIRECTIONS AND ROTATIONS ARE SHOWN ON THE INSTALLATION CONTROL DRAWING, FIGURE 3.

ELECTRICAL BONDING PER MIL-B-5087 OF THE IMU TO THE VEHICLE MOUNTING STRUCTURE SHALL BE ATTAINED BY POSITIVELY CLEANING THE IMU AND VEHICLE SURFACES, AND BY TORQUING THE MOUNTING BOLTS TO THE PRESET RANGE SHOWN IN FIGURE 3. WHEN TORQUING THE IMU, PRESSURE SHOULD BE APPLIED TO THE CONNECTOR SIDE OF THE IMU TO INSURE SIDE CONTACT BETWEEN BOTH THE MOUNTING PINS AND THE IMU BUSHINGS. THE REPEATABILITY OF INSTALLATION SHALL BE ACCURATE TO ±0.5 MILLIRADIANS, SEE NOTE ON FIGURE 3 AND LITTON DRAWING 811069 REV. F.

THE ELECTRICAL INTERFACE FOR SIGNAL LINES AND REGULATED POWER LINES SHALL BE MADE THROUGH A SINGLE SUBMINIATURE CONNECTOR THAT IS HERMETICALLY SEALED AND PROVIDES MEANS TO POSITIVELY RETAIN THE MATING CONNECTOR.

3.1.1.3.1 COOLING. THE IMU SHALL BE CONDUCTIVELY COOLED THROUGH THE IMU CHASSIS TO A CUSTOMER FURNISHED MOUNTING PLATE. THE MOUNTING PLATE SHALL BE A HEATSINK FOR THE IMU 16 WATTS MAXIMUM RUN POWER.

3.1.1.3.2 VIBRATION. INPUT LEVELS TO THE IMU THROUGH A CUSTOMER FURNISHED MOUNTING PLATE SHALL NOT EXCEED OPERATING LIMITS OF 3.2.5E., RANDOM VIBRATION.

3.2 CHARACTERISTICS

3.2.1 PERFORMANCE. THE LN-200 MEETS THE PERFORMANCE REQUIREMENTS SPECIFIED HEREIN UNDER ALL ENVIRONMENTAL CONDITIONS WHEN SUPPLIED WITH THE INPUT POWER DEFINED IN 3.1.1.2. REFER TO TABLE VI FOR SYSTEM PARAMETER SUMMARY AND IMU PERFORMANCE OPTIONS. UNLESS NOTED, INSTRUMENT PERFORMANCE "NOT GREATER THAN" OR "MAXIMUM VALUE" MEANS ±3σ.

3.2.1.1 OPERATING POWER REQUIREMENTS. THE IMU REQUIRES THAT POWER BE APPLIED IN THE FOLLOWING SEQUENCE. ON POWER UP, THE +5V, THE –5V (IF USED) AND THE –15V MUST BE AT THEIR SPECIFICATION LEVELS BEFORE THE +15V IS APPLIED. AT POWER DOWN, THE +15V SHOULD BE REMOVED FIRST BEFORE THE OTHER VOLTAGES ARE REMOVED. FAILURE TO FOLLOW THIS SEQUENCE CAN POTENTIALLY RESULT IN DAMAGE TO THE IMU

3.2.1.1.1 AVERAGE POWER. THE IMU AVERAGE POWER DOES NOT EXCEED 16 WATTS WHEN SUPPLIED WITH THE VOLTAGES SPECIFIED IN TABLE IV.

3.2.1.1.2 POWER CIRCUITS ISOLATION. THE DIRECT CURRENT (DC) IMPEDANCE BETWEEN POWER RETURNS, DATA LINES AND THE CHASSIS IS GREATER THAN 1 MEGOHMS.

3.2.1.1.3 ACTIVATION TIME. WITHIN THE TEMPERATURE RANGE OF -54°C TO +71°C, THE IMU BECOMES FULLY FUNCTIONAL IN LESS THAN 0.8 SECONDS AFTER INITIAL APPLICATION OF INPUT POWER. TIME TO FULL INSTRUMENT ACCURACY MAY BE UP TO 15 SECONDS AFTER POWER IS APPLIED.

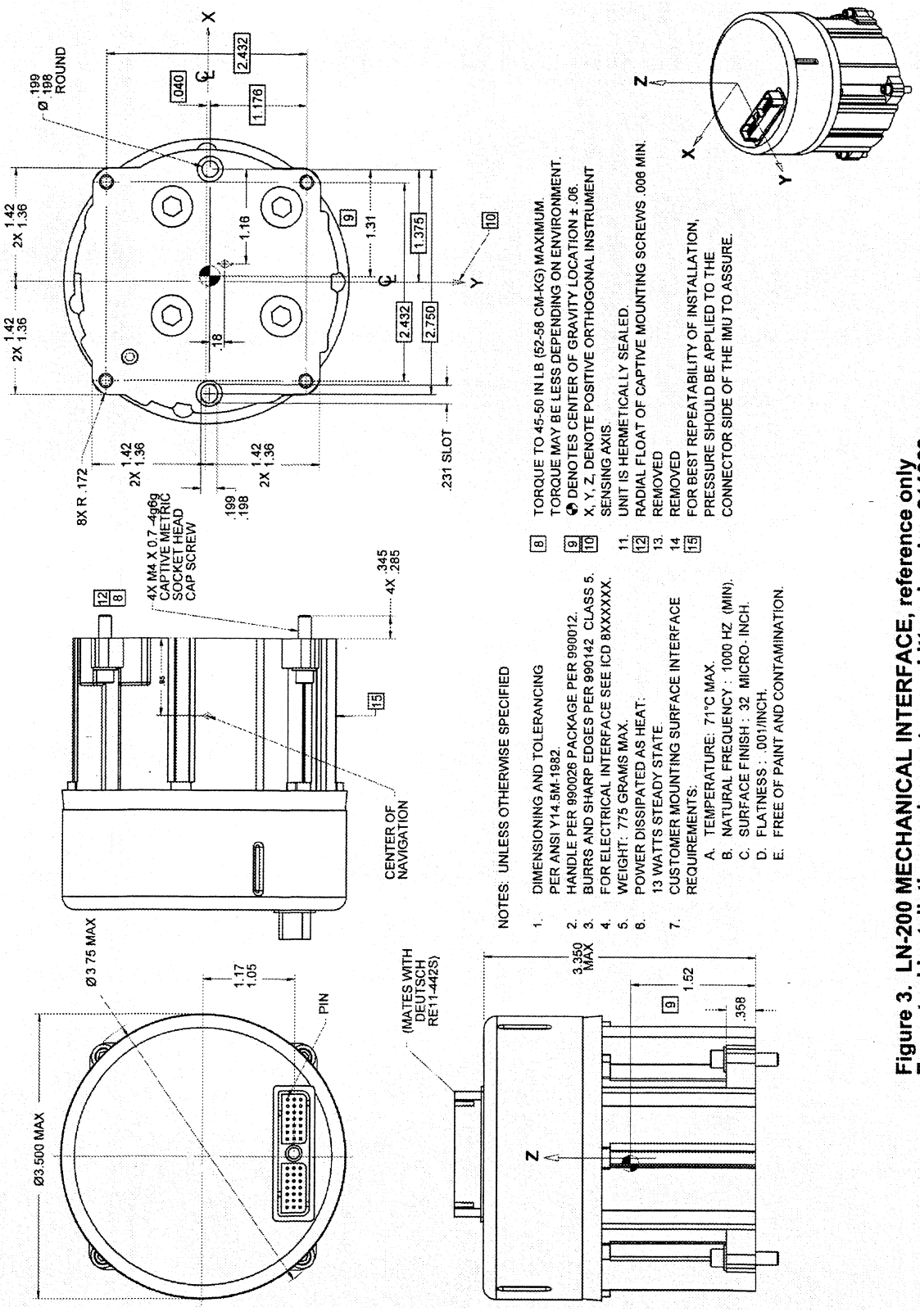


Figure 3. LN-200 MECHANICAL INTERFACE, reference only
For actual installation rquirements, see Litton drawing 811069

LITTON GUIDANCE AND CONTROL SYSTEMS	SIZE A	CAGE CODE 06481	NUMBER 311875	REV AJ
ANY RESTRICTIVE AND / OR NOTICES ON THE SHEET FOR WHICH THIS SHEET SERVES AS A CONTINUATION ARE HEREBY INCORPORATED HERON	SCALE NONE		SHEET 18	

FOR AN INITIAL START AT TEMPERATURES ABOVE +71°C OR RESTART ABOVE +50°C, THE ACTIVATION TIME MAY BE LONGER. FIGURE 4 SHOWS THE NORMAL START AND FAST RESTART TIMELINE.

3.2.1.2 LINEAR ACCELEROMETERS. EACH OF THE THREE LINEAR ACCELEROMETERS OUTPUTS IS PROPORTIONAL TO THE INCREMENTAL VELOCITIES ALONG THE THREE RESPECTIVE VEHICLE AXES. REFER TO TABLE VI FOR SYSTEM PARAMETER SUMMARY.

3.2.1.2.1 AXIS ALIGNMENT. SEE TABLE VI.

3.2.1.2.2 POLARITY. EACH ACCELERATION CHANNEL PROVIDES POSITIVE VELOCITY INCREMENT OUTPUTS WHEN SUBJECTED TO POSITIVE INPUT ACCELERATIONS AS SHOWN IN THE INSTALLATION CONTROL DRAWING, FIGURE 3.

3.2.1.2.3 OPERATING RANGE. EACH ACCELERATION CHANNEL (X AXIS, Y AXIS, Z AXIS) PROVIDES SPECIFIED OUTPUTS FOR INPUT ACCELERATIONS UP TO AT LEAST ±40g. THE LIMIT FOR THE 10Hz OUTPUT DATA RATE OPTION IS 2g. SEE TABLE II.

3.2.1.2.4 FREQUENCY RESPONSE. ABOVE 10 HZ, THE GAIN AND PHASE OF EACH ACCELEROMETER IS A SECOND ORDER RESPONSE. THE GAIN AT 10 HZ IS +0.6 DB ABOVE THE VALUE AT 0 HZ. TOTAL VARIATION IN THE RESPONSE OVER TEMPERATURE IS WITHIN THE FOLLOWING RANGES:

UNDAMPED NATURAL FREQUENCY	100 TO 160 HZ
DAMPING FACTOR RANGE	0.35 TO 0.85

NOTE: THE SINX/X FREQUENCY RESPONSE CAUSED BY THE DATA BUS AND THE BUS DELAY ARE ADDITIONAL TERMS NOT INCLUDED IN THIS PARAGRAPH. SEE SECTION 6.2.D.

3.2.1.2.5 SENSITIVITY. EACH ACCELERATION CHANNEL IS CAPABLE OF DETECTING A CONSTANT ACCELERATION INPUT CHANGE OF 100 μg.

3.2.1.2.6 CROSS-AXIS SENSITIVITY. CROSS-AXIS SENSITIVITY CAUSED BY ACCELERATIONS APPLIED ALONG A NON-SENSITIVE AXIS IS NOT GREATER THAN 50 $\mu g/g^2$.

3.2.1.2.7 VELOCITY QUANTIZATION. THE VELOCITY QUANTIZATION OF THE DELTA VELOCITY OUTPUT IS NOT GREATER THAN 0.00169 FT/SEC OR 0.515 MM/SEC.

3.2.1.2.8 SCALE FACTOR ACCURACY. SEE TABLE VI.

3.2.1.2.9 SCALE FACTOR ASYMMETRY. SEE TABLE VI.

3.2.1.2.10 NULL OFFSETS. THE FOLLOWING REQUIREMENTS APPLY WHEN OUTPUT READINGS ARE AVERAGED OVER AN INTERVAL OF 10 SECONDS.

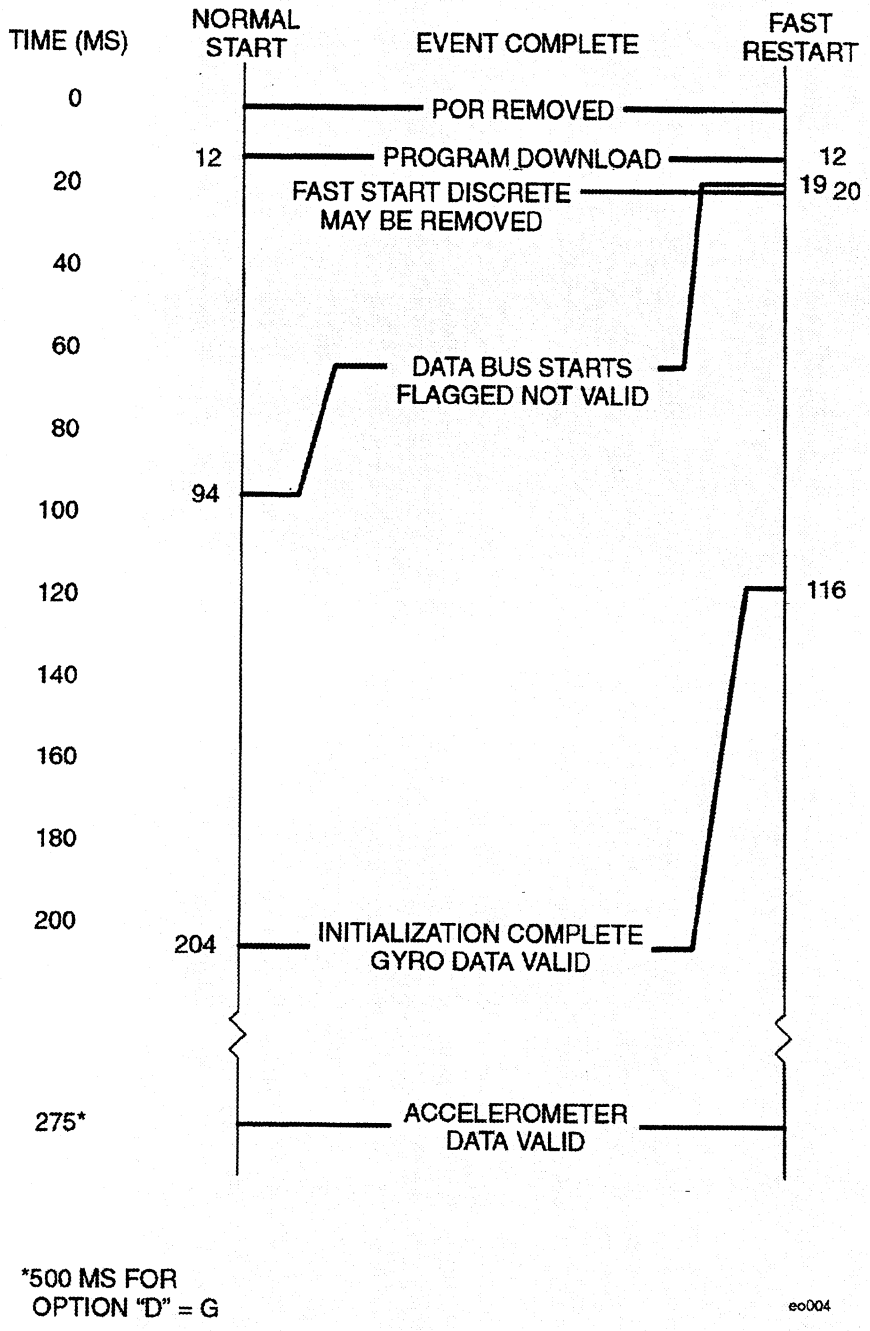


FIGURE 4. LN-200 NORMAL START AND FAST RESTART TIMELINE

LITTON GUIDANCE AND CONTROL SYSTEMS	SIZE A	CAGE CODE 06481	NUMBER 311875	REV AJ
ANY RESTRICTIVE AND / OR NOTICES ON THE SHEET FOR WHICH THIS SHEET SERVES AS A CONTINUATION ARE HEREBY INCORPORATED HERON	SCALE NONE		SHEET 20	

TABLE VI. SYSTEM PERFORMANCE SUMMARY

IMU OPTIONS	A = 1	A = 2	A = 3
IMU OPTIONS LESS ACCELEROMETERS	A = 6	A = 7	A = 8 NO TEMP CAL FIXED MODEL
ACCELEROMETER			
PARAMETERS WITH 1 SIGMA VALUES			
AXIS MISALIGNMENT	0.1 MR	0.3 MR	3.0 MR
SCALE FACTOR ACCURACY	300 PPM	1000 PPM	5000 PPM
SCALE FACTOR ASYMMETRY	150 PPM	500 PPM	2500 PPM
NULL ACCURACY (BIAS)	300 µG	1.5 MG	3.0 MG
NULL VIBRATION SHIFT	50 $\mu G/G^2$	50 $\mu G/G^2$	100 $\mu G/G^2$
RANGE (MAX)	40G		
NOISE RMS (10 SEC INTERVAL)	35 µG		
GYRO			
PARAMETERS WITH 1 SIGMA VALUES			
AXIS MISALIGNMENT	0.1 MR	0.3 MR	3.0 MR
SCALE FACTOR ACCURACY	100 PPM	100 PPM	500 PPM
DRIFT	1°/HR	3°/HR	8°/HR
RANDOM WALK	$0.07°/\sqrt{HR}$	$0.15°/\sqrt{HR}$	$0.15°/\sqrt{HR}$
G-SENSITIVE BIAS	0.01°/HR/G	0.01°/HR/G	0.03°/HR/G
VIBRATION SENSITIVE BIAS	$0.02°/HR/G^2$	$0.02°/HR/G^2$	$0.1°/HR/G^2$
INPUT RANGE (MAX)	1000°/SEC		
ANGULAR ACCELERATION (MAX)	$100{,}000°/SEC^2$		

SEE SECTION 6.3 FOR PERFORMANCE LIMITS OF OTHER OPTIONS.

3.2.1.2.10.1 NULL ACCURACY. SEE TABLE VI.

3.2.1.2.10.2 NULL VIBRATION SHIFT. SEE TABLE VI.

3.2.1.2.11 OUTPUT NOISE. WITH THE UNIT AT REST, TOTAL ACCELERATION CHANNEL OUTPUT NOISE DOES NOT EXCEED 35 µg RMS (10 SEC INTERVAL).

THE SILICON ACCELEROMETER HAS SEVERAL NOISE TERMS. THE THREE MOST IMPORTANT TERMS ARE:

WHITE NOISE	$50\mu g\sqrt{S}$
VELOCITY QUANTIZATION	0.00049 F/S RMS
MODEING	0.0055 F/S RMS

QUANTIZATION AND MODEING HAVE SIMILAR SYSTEM CHARACTERISTICS. THEY ARE BOTH A VELOCITY NOISE AND DO NOT INTEGRATE WITH TIME. THE EQUIVALENT ACCELERATION NOISE IS A FUNCTION OF 1/T. SINCE THE VELOCITY QUANTIZATION IS SMALL COMPARED TO THE MODEING, THE TOTAL VELOCITY NOISE CAN BE REPRESENTED BY JUST USING THE MODEING VALUE, 0.0055 F/S OR 172 µgS. USING THE LAST FORM, THE SIAC NOISE TERMS CAN BE COMBINED TO GIVE A TOTAL NOISE OF :

$$N^2 = \frac{\left(50\,\mu g\sqrt{S}\right)^2}{T} + \frac{\left(172\,\mu gS\right)^2}{T^2}$$

EXAMPLES:	T = 1 SEC;	N = 179 µg RMS
	T = 10 SEC;	N = 23 µg RMS
	T = 30 SEC;	N = 11 µg RMS

3.2.1.3 GYROS. THE IMU INCORPORATES THREE SINGLE–AXIS FIBER OPTIC GYRO CHANNELS TO PROVIDE CONTINUOUS INDICATION OF VEHICLE ANGLE CHANGES. EACH GYRO OPERATES IN A CLOSED–LOOP MODE WITH INCREMENTAL ANGLE OUTPUTS PROPORTIONAL TO THE ANGULAR CHANGES ABOUT THE THREE RESPECTIVE VEHICLE AXES. REFER TO TABLE VI FOR A SUMMARY OF SYSTEM PARAMETERS.

3.2.1.3.1 AXIS ALIGNMENT. SEE TABLE VI.

3.2.1.3.2 POLARITY. EACH GYRO CHANNEL PROVIDES POSITIVE ANGLE INCREMENTAL OUTPUTS WHEN SUBJECTED TO POSITIVE INPUT ROTATIONS ABOUT THE IMU AXES SHOWN IN THE INSTALLATION CONTROL DRAWING, FIGURE 3.

3.2.1.3.3 OPERATING RANGE. EACH INCREMENTAL ANGLE CHANNEL PROVIDES THE SPECIFIED OUTPUTS FOR INPUT ANGULAR RATES UP TO AT LEAST ±1000 °/SEC, AND ANGULAR ACCELERATIONS UP TO AT LEAST 100,000 °/SEC^2. THE LIMIT FOR THE 10 HZ OUTPUT DATA RATE OPTION IS ±35.8 °/SEC. SEE TABLE II. SEE SECTION 6.3 FOR ADDITIONAL INFORMATION ABOUT ANGULAR RATE RANGES AND THE RATE RANGE BIT LIMIT.

3.2.1.3.4 FREQUENCY RESPONSE. THE GYRO LOOP FREQUENCY RESPONSE IS FLAT TO WITHIN 3dB OVER THE RANGE FROM ZERO TO AT LEAST 100,000 Hz. THE FREQUENCY RESPONSE OF THE GYRO OUTPUT ON THE DATA BUS IS THE PRODUCT OF TWO TERMS. THE FIRST IS THE NORMAL SINX/X CAUSED BY THE DATA BUS RATE. THE SECOND TERM IS A MOVING AVERAGE FILTER WITH A NOTCH AT THE OUTPUT DATA RATE.

FOR A DATA RATE OF 400 Hz, THE GYRO BANDWIDTH IS ABOUT 200 Hz. SEE SECTION 6.2.D

3.2.1.3.5 SENSITIVITY. EACH INCREMENTAL ANGLE CHANNEL HAS A MAXIMUM THRESHOLD OF 0.1 °/HR.

3.2.1.3.6 ANGLE QUANTIZATION. THE ANGLE QUANTIZATION OF THE DELTA ANGLE OUTPUT IS LESS THAN 0.05 ARCSEC.

3.2.1.3.7 SCALE FACTOR ACCURACY. SEE TABLE VI.

3.2.1.3.8 RANDOM WALK. SEE TABLE VI.

3.2.1.3.9 DRIFT. SEE TABLE VI.

3.2.1.3.10 G-SENSITIVE BIAS. SEE TABLE VI.

3.2.1.3.11 VIBRATION SENSITIVE BIAS. SEE TABLE VI.

3.2.1.4 BUILT-IN-TEST (BIT)

3.2.1.4.1 TURN-ON BIT. BIT IS PERFORMED DURING THE FIRST 275 MS (500 MS FOR OPTION D = G) AFTER IMU POWER–ON–RESET* (PIN G1) GOES HIGH. THIS SELF-TEST BIT HAS THE CAPABILITY TO DETECT 95% OF THE RELIABILITY CRITICAL FAILURES. THE BIT FALSE ALARM RATE (INDICATES FAILURE WHEN NONE HAS OCCURRED) IS NOT GREATER THAN 1%.

3.2.1.4.2 PERIODIC BIT. DURING OPERATION, ALL TURN–ON BIT TESTS THAT DO NOT AFFECT IMU OPERATION ARE PERFORMED. IMU SHUTDOWN DUE TO FAILURE OF BIT MAY BE INHIBITED.

3.2.1.4.3 COMMANDED BIT. UPON RECEIPT OF THE COMMANDED BIT COMMAND, THE IMU PERFORMS THE FOLLOWING DISRUPTIVE TESTS: DELTA VELOCITY COUNTER WRAPAROUND TEST AND GYRO LOOP CONTROL ANGULAR RATE TEST. THIS BIT CONTINUES FOR 100 MS AFTER THE BIT COMMAND IS REMOVED. THE IMU WILL NOT MEET PERFORMANCE REQUIREMENTS DURING INITIATED BIT.

3.2.2 PHYSICAL CHARACTERISTICS

3.2.2.1 WEIGHT. THE TOTAL IMU WEIGHT IS LESS THAN 775 GRAMS.

3.2.2.2 DIMENSIONS AND MOUNTING. THE IMU CONFORMS TO THE MECHANICAL DRAWING 811069.

3.2.2.3 USEFUL LIFE. THE UNIT HAS A USEFUL LIFE OF 20 YEARS.

3.2.3 RELIABILITY. PREDICTED MTBF OF THE UNIT IS GREATER THAN 20,000 HOURS WHEN OPERATED IN AN AIRBORNE ROTARY WING ENVIRONMENT AT 53 °C, AND 25,000 HOURS WHEN OPERATED IN A MISSILE LAUNCH ENVIRONMENT AT 60 °C. MIL-HDBK-217 IS USED FOR THESE PREDICTIONS.

3.2.4 MAINTAINABILITY. THE IMU IS READILY REPLACEABLE AT THE ORGANIZATION LEVEL AND REPAIRED AT THE DEPOT LEVEL.

3.2.4.1 PREVENTIVE MAINTENANCE. NO PREVENTIVE MAINTENANCE IS REQUIRED FOR THE IMU.

3.2.5 ENVIRONMENTAL CONDITIONS. THE IMU MEETS ALL PERFORMANCE AND FUNCTIONAL REQUIREMENTS OF 3.2.1 WHILE EXPOSED TO THE FOLLOWING ENVIRONMENTS:

A.	TEMPERATURE/ALTITUDE	
	CONTINUOUS OPERATION	-54 °C TO +71 °C, INSTALLED PER 3.1.1.3
	NON–OPERATING/STORAGE	-62 °C TO +85 °C, WITHOUT REGARD TO INSTALLATION
	TEMPERATURE SHOCK RATE	-54 °C TO +85 °C AT 20 °C/MIN
	ALTITUDE OPERATING	S.L. TO +500,000 FT
B.	HUMIDITY	0 TO 100% R.H. FOR 5 DAYS
C.	SAND AND DUST	OPERATING AND NON-OPERATING EXPOSURE TO SAND AND DUST PARTICLES IN ACCORDANCE WITH MIL-STD-810E, METHOD 510.3, PROCEDURE I
D.	SALT FOG	OPERATING AND NON-OPERATING EXPOSURE TO SALT FOG IN ACCORDANCE WITH MIL-STD-810E, METHOD 509.3
E.	VIBRATION	
	SINUSOIDAL	RESONANCE SEARCH UP TO 500 HZ AT 0.5G. EXPOSURE TIME NTE 15 MINUTES/AXIS
	RANDOM VIBRATION	15 g RMS, 20 HZ TO 2,000 HZ, AT A PSD NTE 0.114 g^2/HZ IN ANY BANDWIDTH. EXPOSURE TIME IS NOT TO EXCEED 30 MINUTES PER AXIS

F.	SHOCK	
	OPERATING	90g, 6 MS TERMINAL SAWTOOTH
	NON–OPERATING/STORAGE	320g, 5 MS 1/2 SINE
	PEAK SHOCK RESPONSE SPECTRA	400g/100 HZ, 1500g/1000 HZ
G.	MAGNETIC FIELD	10 GAUSS, AFTER A NON–OPERATING EXPOSURE TO 20 GAUSS
H.	ACOUSTICS	150 DB, 20 HZ-20 KHZ, 7 MINUTES PER MIL-STD-810E, METHOD 515.4, PROCEDURE II

3.3 DESIGN AND CONSTRUCTION. THE IMU IS A HERMETICALLY SEALED UNIT AND COMPLIES WITH THE DESIGN AND CONSTRUCTION REQUIREMENTS SPECIFIED HEREIN.

3.3.1 MATERIALS, PROCESSES, AND PARTS. MATERIALS, PROCESSES, AND PARTS ARE COMPATIBLE WITH THE PERFORMANCE REQUIREMENTS OF THIS SPECIFICATION.

3.3.1.1 CORROSION RESISTANCE. THE IMU MAY BE TEMPORARILY EXPOSED TO AN ENVIRONMENT WITH SALT AIR AND CONDENSATION. APPROPRIATE COATINGS OR SURFACE TREATMENTS ARE APPLIED TO PROVIDE CORROSION RESISTANCE, AND MEET GUIDELINE 15 OF MIL-HDBK-454.

3.3.1.2 FUNGUS NUTRIENT. MATERIALS WHICH ARE FUNGUS NUTRIENT ARE NOT USED EXCEPT IN HERMETICALLY SEALED ASSEMBLIES OR IF PROTECTED WITH FUNGUS PROTECTIVE FINISHES. FUNGUS INERT MATERIALS CONFORM TO GUIDELINE 4 OF MIL-HDBK-454.

3.3.1.3 DISSIMILAR METALS. UNLESS SUITABLY PROTECTED, DISSIMILAR METALS ARE NOT USED IN INTIMATE CONTACT. DISSIMILAR METALS ARE PROTECTED IN ACCORDANCE WITH GUIDELINE 16 OF MIL-HDBK-454.

3.3.1.4 PROTECTIVE TREATMENT. MATERIALS SUBJECTED TO DETERIORATION OR CORROSION WHEN EXPOSED TO CLIMATE OR OTHER ENVIRONMENTAL CONDITIONS SPECIFIED HEREIN ARE PROTECTED AGAINST SUCH DETERIORATION OR CORROSION IN A MANNER THAT WILL IN NO WAY ADVERSELY AFFECT COMPLIANCE WITH THE PERFORMANCE AND LIFE REQUIREMENTS SPECIFIED HEREIN.

3.3.1.5 FINISHES.

A.	CONNECTOR SHELL	NICKEL PLATE PER QQ-N-290, CLASS 1, .0002 MIN. THICKNESS
B.	CHASSIS	CHEMICAL FILM PER MIL-C-5541, CLASS 3

C. COVER — NICKEL PLATE PER QQ-N-290, CLASS II, GRADE E MINIMUM

D. WELD ZONE BETWEEN COVER & CHASSIS — BARE ALUMINUM BAND APPROXIMATELY 0.6 INCH WIDE ALL AROUND UNIT

3.3.1.6 PARTS CONTROL PROGRAM. AN IMU PARTS CONTROL AND STANDARDIZATION PROGRAM IS IMPLEMENTED IN ACCORDANCE WITH LITTON'S DOCUMENT NO. 408600 AS A GUIDE. POSITIVE CONTROL SHALL BE IMPOSED TO MINIMIZE THE OVERALL NUMBER AND TYPE OF PARTS INCORPORATED IN THE DESIGN OF THE EQUIPMENT WITH CONSIDERATION GIVEN TO DURABILITY, MATERIALS CHARACTERIZATION AND DESIGN REQUIREMENTS.

3.3.1.6.1 SOLDERING. SOLDERING AND SOLDERING PROCESSES TO MAKE ELECTRICAL CONNECTIONS OF PARTS TO WIRES, CABLES, CONNECTORS, PRINTED WIRING BOARDS AND LIKE PARTS, CONFORMS TO 992055.

3.3.1.7 ELECTROSTATIC DISCHARGE PROTECTION. METAL OXIDE SEMICONDUCTOR (MOS PARTS AND OTHER PARTS SENSITIVE TO ELECTROSTATIC DISCHARGE (ESD) ARE UTILIZED IN THE EQUIPMENT. PROCEDURES IN ACCORDANCE WITH MIL-STD-1686 ARE UTILIZED AS GUIDANCE FOR THE PROTECTION OF ELECTRONIC COMPONENTS AND ASSEMBLIES. SPARE PARTS, MODULES, PRINTED CIRCUIT BOARDS, SUBASSEMBLIES, ETC., SHALL BE PROTECTED FROM ESD.

3.3.2 ELECTROMAGNETIC RADIATION

3.3.2.1 ELECTROMAGNETIC COMPATIBILITY (EMC). THE IMU COMPLIES WITH THE ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS STATED IN MIL-E-6051.

3.3.2.2 ELECTROMAGNETIC INTERFERENCE (EMI)

A. CONDUCTED EMISSIONS. THE TIME DOMAIN VOLTAGE WAVEFORMS FOR SPIKE AND RIPPLE ON THE INPUT POWER LINES SHALL NOT EXCEED 150 MV P–P ON THE +5 V DC AND -5 V DC INPUTS, AND 300 MV P–P ON THE +15 V DC AND -15 V DC INPUTS. THESE MEASUREMENTS SHALL BE PERFORMED USING A 5 mH LOW IMPEDANCE STABILIZATION NETWORK (LISN) AS DESCRIBED IN MIL-STD-462, NOTICE 3, FIGURES 7 AND 8, INSTALLED IN EACH INPUT POWER LINE. THE VOLTAGES SHALL BE OBSERVED USING AN OSCILLOSCOPE HAVING A BANDWIDTH GREATER THAN 50 MHZ TO DETERMINE THE PEAK–TO–PEAK VOLTAGE ACROSS THE 50 OHM LISN TERMINATING RESISTOR.

B. CONDUCTED SUSCEPTIBILITY. THE IMU IS IMMUNE TO AN INJECTED VOLTAGE OF 150 MV P–P ON THE +5 V DC AND -5 V DC POWER INPUTS, AND 300 MV P–P ON THE +15 V DC AND -15 V DC POWER INPUTS, OVER THE FREQUENCY RANGE OF 30 HZ TO 50 MHZ. TEST METHODS SIMILAR TO THOSE DESCRIBED IN MIL-STD-462, NOTICE 2, CS01 AND CS02, ARE USED TO VERIFY THIS IMMUNITY.

C. RADIATED EMISSIONS. THE IMU MEETS THE AIR FORCE AND NAVY RE02 REQUIREMENTS OF MIL-STD-461C, PART 2, CATEGORY A1B, WHEN INSTALLED IN A STRUCTURE WHICH PROVIDES 40 DB OF SHIELDING.

D. RADIATED SUSCEPTIBILITY. THE IMU MEETS THE AIR FORCE AND NAVY RS02 AND RS03 REQUIREMENTS OF MIL-STD-461C, PART 2, CATEGORY A1B, WHEN INSTALLED IN A STRUCTURE WHICH PROVIDES 40 DB OF SHIELDING.

3.3.2.3 GROUNDING AND BONDING. THE SINGLE POINT GROUNDING (SPG) CONCEPT IS UTILIZED IN THE IMU DESIGN. THE ENCLOSURE OR THE CASE IS NOT USED AS THE INTENTIONAL CURRENT RETURN PATH. THE IMU INTERNALLY MEETS MIL-B-5087, CLASS R BONDING REQUIREMENTS.

3.3.2.4 MAGNETIC FIELD. THE PERFORMANCE OF THE IMU IS NOT DEGRADED BEYOND SPECIFICATION LIMITS DURING EXPOSURE TO STEADY STATE STRAY FIELDS OF 10 GAUSS MAXIMUM.

3.3.3 NAMEPLATES AND PRODUCT MARKING. EVERY IMU IS MARKED AND IDENTIFIED IN ACCORDANCE WITH MIL-STD-130. THE IMU FUNCTIONAL ITEM REPLACEMENT (FIR), MAJOR ASSEMBLIES, AND DOWN TO THE LEVEL OF CIRCUIT CARD ASSEMBLY ARE IDENTIFIABLE BY PART NUMBER AND SERIAL NUMBER. ALUMINUM FOIL NAMEPLATES ARE ATTACHED BY ADHESIVE BONDING. ELECTROSTATIC WARNING DECALS ARE APPLIED, AS REQUIRED.

3.3.4 WORKMANSHIP. ALL ELEMENTS OF THE IMU ARE CONSTRUCTED AND FINISHED IN ACCORDANCE WITH GUIDELINE 9 OF MIL-HDBK-454.

3.3.5 INTERCHANGEABILITY. COMPONENTS, MODULES, AND PARTS OF IDENTICAL SUBASSEMBLIES ARE FUNCTIONALLY AND MECHANICALLY INTERCHANGEABLE IN ACCORDANCE WITH GUIDELINE 7 OF MIL-HDBK-454.

3.3.6 SYSTEM SAFETY

3.3.6.1 DESIGN CRITERIA. THE IMU WAS DESIGNED TO MINIMIZE THE OCCURRENCE OF FALSE OR ERRONEOUS SIGNALS OR TEST OUTPUTS THAT ARE UNDETECTED AND NOT REPORTED FOR ALL NORMAL AND ABNORMAL OPERATING CONDITIONS AND FAILURE MODES. THE IMU CONFORMS TO THE APPLICABLE REQUIREMENTS CONTAINED IN THE FOLLOWING DOCUMENTS:

A. SAFETY PROGRAM, MIL-STD-882C

B. PERSONNEL SAFETY, MIL-HDBK-454, GUIDELINE 1

C. ELECTROMAGNETIC HAZARDS, MIL-STD-1385B

3.3.6.2 DESIGN HAZARDS. THE DESIGN OF THE IMU PRECLUDES THE OCCURRENCE OF EVENTS THAT RESULT IN A HAZARD TO PERSONNEL OR ASSOCIATED EQUIPMENT DUE TO THE OCCURRENCE OF A SINGLE POINT FAILURE OR OF TWO OR MORE FAILURES UNLESS THEIR TOTAL PROBABILITY OF OCCURRENCE IS 0.5×10^{-6} OR LESS. THE IMU IS ASSUMED TO BE PROPERLY FUNCTIONING IMMEDIATELY PRIOR TO THE CRITICAL TIME PERIOD WHEN THE HAZARD MAY OCCUR.

3.3.6.3 DESIGN FEATURES. THE DESIGN INCORPORATES SAFETY FEATURES THAT PROVIDE MAXIMUM SAFETY AND PROTECTION OF OPERATING AND MAINTENANCE PERSONNEL AND ASSOCIATED EQUIPMENT.

3.3.7 HUMAN FACTORS ENGINEERING. THE IMU INCORPORATES HUMAN ENGINEERING DESIGN CRITERIA CONFORMING TO MIL-STD-1472D, WHERE PRACTICAL, UTILIZING OPTIMUM AND ECONOMICAL DESIGN CONSIDERATION. THE DESIGN FEATURES TAKE INTO ACCOUNT HUMAN ENGINEERING FACTORS THAT AFFECT HUMAN PERFORMANCE.

3.3.8 SOFTWARE

3.3.8.1 TIME LOADING. THE IMU DIGITAL COMPUTER AVERAGE TIME LOADING FACTOR DOES NOT EXCEED 70 PERCENT EXCEPT FOR THE 3600 HZ DATA RATE OUTPUT OPTION WHICH DOES NOT EXCEED 90 PERCENT.

3.3.8.2 MEMORY USAGE. MEMORY USED FOR TEMPORARY DATA STORAGE OR FOR INSTRUCTION STORAGE HAS A USAGE FACTOR NOT EXCEEDING 70 PERCENT.

3.4 DOCUMENTATION. SOFTWARE DOCUMENTATION IS PREPARED IN ACCORDANCE WITH DOD-STD-2167A AS TAILORED FOR LITTON GCS STANDARDS. ENGINEERING DRAWINGS COMPLY WITH THE STANDARDS OF DOD-D-1000, LEVEL 2.

3.5 LOGISTICS. THE IMU WAS DESIGNED FOR MAINTENANCE AT ON–EQUIPMENT, OFF–EQUIPMENT AND DEPOT LEVELS OF REPAIR. MAINTENANCE AT ON–EQUIPMENT AND OFF–EQUIPMENT LEVELS IS REMOVAL AND REPLACEMENT OF THE IMU USING BIT/BITE AS THE MEANS FOR FAULT DETECTION AND CHECKOUT. DEPOT LEVEL MAINTENANCE CONSISTS OF REPAIR TO THE SUBASSEMBLY OR PIECE PART LEVEL OF EQUIPMENT.

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL. TESTS, DEMONSTRATIONS, AND/OR ANALYSES EXIST TO VERIFY CONFORMANCE TO THE REQUIREMENTS OF PARAGRAPH 3 OF THIS SPECIFICATION. THESE QUALITY EVALUATIONS CONFORM TO THE REQUIREMENTS OF MIL-Q-9858 AND ARE CONSISTENT WITH THE LN-200 IMU OBJECTIVES.

4.1.1 RESPONSIBILITY FOR TESTS. UNLESS OTHERWISE SPECIFIED IN THE CONTRACT, THE SUPPLIER IS RESPONSIBLE FOR THE PERFORMANCE OF ALL INSPECTION REQUIREMENTS.

4.1.2 SPECIAL TESTS AND EXAMINATIONS. THE IMU IS SUBJECTED TO THE FOLLOWING TESTS, CONDUCTED IN ACCORDANCE WITH THE TEST PLANS AND PROCEDURES, TO VERIFY ITS PERFORMANCE:

A. ACCEPTANCE TESTS

B. QUALIFICATION TESTS

C. DESIGN VERIFICATION TESTS

4.1.2.1 ACCEPTANCE TESTS. EACH DELIVERABLE IMU IS SUBJECTED TO THE FOLLOWING TESTS, CONDUCTED IN ACCORDANCE WITH THE TEST PLANS AND PROCEDURES, TO VERIFY THAT UNITS OPERATE PROPERLY, MEET WORKMANSHIP STANDARDS, AND ARE READY FOR DELIVERY:

A. CONFIGURATION/WORKMANSHIP INSPECTIONS

B. FUNCTIONAL PERFORMANCE TESTS

C. ENVIRONMENTAL STRESS SCREENING

4.1.2.1.1 CONFIGURATION/WORKMANSHIP INSPECTIONS. CONFIGURATION/ WORKMANSHIP INSPECTIONS ARE PERFORMED ON EACH DELIVERABLE UNIT. THESE INSPECTIONS VERIFY THE SECTION 3 PHYSICAL REQUIREMENTS SUCH AS WEIGHT, SIZE, NAMEPLATES, MARKINGS, ETC., AS WELL AS VERIFY PROPER WORKMANSHIP.

4.1.2.1.2 FUNCTIONAL PERFORMANCE TESTS. FUNCTIONAL PERFORMANCE TESTS ARE PERFORMED ON EACH DELIVERABLE UNIT. THESE TESTS VERIFY THE SECTION 3 PERFORMANCE REQUIREMENTS. EXCEPT WHERE OTHERWISE SPECIFIED, THE FOLLOWING STANDARD AMBIENT CONDITIONS SHALL PREVAIL FOR ALL FUNCTIONAL PERFORMANCE TESTS.

A.	TEMPERATURE	ROOM AMBIENT, 60° TO 95 °F
B.	ALTITUDE	LOCAL TEST ENVIRONMENTS
C.	HUMIDITY	LOCAL AMBIENT TO 85 PER CENT MAXIMUM
D.	ACCELERATION	LOCAL EARTH G FIELD

4.1.2.1.3 ENVIRONMENTAL STRESS SCREENING. EACH IMU IS SUBJECTED TO ENVIRONMENTAL SCREENING CONSISTING OF THERMAL CYCLING AND RANDOM VIBRATION. THE EQUIPMENT UNDER TEST IS OPERATIONAL AND MONITORED FOR PROPER OPERATION BY USE OF BIT DURING BOTH THERMAL AND RANDOM VIBRATION TESTING; EXCEPT THE EQUIPMENT POWER IS OFF DURING CHAMBER COOLDOWN AND COLD SOAK. ALL FAILURES OCCURRING DURING THESE TESTS WILL BE CORRECTED AND THE TEST RESUMED. MANUFACTURING SCREENING IS APPLIED TO ALL IMUS DELIVERED.

4.1.2.1.3.1 TEMPERATURE CYCLING. EACH IMU IS SUBJECTED TO THERMAL CYCLING FOR FIVE CYCLES OF FAILURE FREE OPERATION. THE TEMPERATURE RATE OF CHANGE IS GREATER THAN 5 °C PER MINUTE. UNIT POWER IS TURNED OFF DURING COOL DOWN AND ON AT STABILIZATION. THE TEMPERATURE RANGE FOR THERMAL CYCLING IS BETWEEN -54 °C AND +71 °C. THE NEXT TEMPERATURE RAMP STARTS WHEN THE INTERNAL PARTS HAVE STABILIZED WITHIN 5 °C OF THE SPECIFIED TEMPERATURE AND THE FUNCTIONAL CHECKS HAVE BEEN COMPLETED. ALL OPERATING TIME AND FAILURES ARE RECORDED.

4.1.2.1.3.2 RANDOM VIBRATION. ALL HARDWARE, INCLUDING CABLES AND CONNECTORS, ARE EXPOSED TO RANDOM VIBRATION (SPECTRAL DENSITY CONSTANT AT 0.025 g^2/HZ FROM 20 TO 2000 HZ) ALONG AN AXIS THAT IS SIMULTANEOUSLY 54.7 +/- 3 DEGREES FROM EACH INPUT AXIS AS SPECIFIED IN FIGURE 3. THE DURATION OF THE VIBRATION IS ONE MINUTE OR GREATER FAILURE FREE.

4.1.2.1.3.3 RETEST AFTER REPAIR. THE EXTENT OF THE RETEST REQUIRED AFTER REPAIR WILL BE DETERMINED BY TEST ENGINEERING AND WILL BE BASED UPON THE EXTENT OF REWORK PERFORMED.

4.1.2.2 QUALIFICATION TESTS. A SAMPLE OF IMUS MANUFACTURED UNDER THE SAME CONDITIONS AS THOSE PROPOSED FOR SUBSEQUENT PRODUCTION SHALL BE SUBMITTED FOR QUALIFICATION TESTS. THE IMU SAMPLES SHALL HAVE SUCCESSFULLY PASSED THE ACCEPTANCE TESTS PRIOR TO SUBMISSION FOR QUALIFICATION TESTING.

4.1.2.2.1 PERFORMANCE QUALIFICATION. ALL PERFORMANCE REQUIREMENTS OF SECTION 3 SHALL BE DEMONSTRATED ON A QUALIFICATION IMU. TESTS SHALL BE CONDUCTED WITH APPROVED TEST PLANS AND PROCEDURES.

4.1.2.2.2 EMI QUALIFICATION. THE EMI TESTS CALLED OUT IN PARAGRAPH 3.3.2 SHALL BE CONDUCTED AS DESCRIBED IN MIL-STD-462 IN ACCORDANCE WITH APPROVED TEST PLANS/PROCEDURES.

4.1.2.2.3 ENVIRONMENTAL TESTS. THE IMU SHALL BE SUBJECTED TO ENVIRONMENTAL TESTING TO VERIFY THE REQUIREMENTS OF PARAGRAPH 3.2.5. A LIMITED OPERABILITY TEST SHALL BE USED BETWEEN NONOPERATING ELEMENTS OF THE ENVIRONMENTAL TEST PROGRAM TO VERIFY THAT THE UNIT REMAINS OPERABLE.

4.1.2.3 DESIGN VERIFICATION TESTS. DESIGN VERIFICATION TESTS SHALL BE PERFORMED TO ACQUIRE DATA AS NECESSARY TO SUPPORT THE DESIGN AND DEVELOPMENT OF THE IMU.

4.2 QUALITY CONFORMANCE INSPECTIONS

4.2.1 TECHNIQUES. THE IMPLEMENTATION OF THESE INSPECTIONS SHALL BE ACCOMPLISHED IN ACCORDANCE WITH THE UNIT TEST MATRIX DESCRIBED IN 4.2.2. FOR PURPOSES OF THIS SPECIFICATION, THE DEFINITIONS OF THE FOUR QUALITY CONFORMANCE INSPECTION TECHNIQUES ARE AS FOLLOWS.

4.2.1.1 EXAMINATION (E). EXAMINATION IS USED IN THE INSPECTION OF ENGINEERING DOCUMENTATION AND EQUIPMENT DURING PRODUCT DEVELOPMENT TO DETERMINE CONFORMANCE WITH SPECIFIED REQUIREMENTS. EXAMINATION IS NON–DESTRUCTIVE AND CONSISTS OF VISUAL INSPECTIONS OR SIMPLE MEASUREMENTS WITHOUT THE USE OF PRECISION MEASUREMENT EQUIPMENT.

4.2.1.2 ANALYSIS (A). ANALYSIS IS A STUDY OF DATA AND IS USED TO VERIFY DESIGN REQUIREMENTS. THESE DATA MAY BE DERIVED FROM ENGINEERING DRAWINGS AND/OR EXAMINATION INSPECTIONS.

4.2.1.3 TEST (T). TEST IS A TECHNIQUE USED TO VERIFY FUNCTIONAL CHARACTERISTICS. THE TEST PROCESS SHALL GENERATE DATA, AND THESE DATA ARE NORMALLY RECORDED BY PRECISION MEASUREMENT EQUIPMENT OR PROCEDURES. ANALYSIS IS SUBSEQUENTLY PERFORMED ON THE DATA DERIVED FROM THE TESTING. ANALYSIS AS DESCRIBED HERE IS AN INTEGRAL PART OF THIS TECHNIQUE AND SHOULD NOT BE CONFUSED WITH THE ANALYSIS DESCRIBED IN 4.2.1.2 ABOVE.

4.2.1.4 DEMONSTRATION (D). DEMONSTRATION IS A VARIATION OF TEST USED TO VERIFY PERFORMANCE WITHOUT THE USE OF ELABORATE EQUIPMENT. THUS, OPERATION OF A UNIT IN OR NEAR ITS USE–ENVIRONMENT WOULD BE DEFINED AS A "DEMONSTRATION" RATHER THAN A "TEST."

4.2.1.5 NOT APPLICABLE (NA). THIS REFERS TO A TITLE/SUBTITLE OR DESCRIPTIVE MATERIAL WITH NO DEMONSTRABLE REQUIREMENT.

4.2.2 PERFORMANCE VERIFICATION. COMPLIANCE WITH THE PERFORMANCE REQUIREMENTS OF SECTION 3 AND THE APPENDICES SHALL BE VERIFIED AS INDICATED IN TABLE VII BY EXAMINATION, ANALYSIS, DEMONSTRATION, TEST OR A COMBINATION THEREOF.

4.2.2.1 MAINTAINABILITY TEST. THIS TEST IS NOT REQUIRED BECAUSE THE IMU IS TREATED AS AN SRU TO BE RETURNED TO DEPOT FOR REPAIR.

4.2.2.2 BUILT-IN TEST. THE BIT CAPABILITY SHALL BE VERIFIED BY ANALYSIS AND DATA FROM SIMILAR DESIGNS.

4.2.2.3 RELIABILITY ANALYSIS. A RELIABILITY PREDICTION USING MIL-HDBK-217 AS A GUIDE, SHALL BE PERFORMED TO VERIFY THE IMU WILL MEET THE REQUIREMENTS OF 3.2.3. TEST DATA STARTING WITH SRU (CIRCUIT CARD LEVEL TESTING) SHALL BE COLLECTED, ANALYZED AND UTILIZED TO PROJECT RELIABILITY GROWTH AT THE IMU LEVEL.

TABLE VII. UNIT TEST MATRIX

PARAGRAPH NUMBER	REQUIREMENT PARAGRAPH TITLE	VERIFICATION METHOD E	A	D	T	N/A
3.	REQUIREMENTS					X
3.1	ITEM DEFINITION					X
3.1.1	FUNCTIONAL INTERFACES					X
3.1.1.1	ELECTRICAL SIGNAL INTERFACE				X	
3.1.1.1.1	DISCRETE INPUTS AND OUTPUTS				X	
3.1.1.1.2	OTHER SIGNALS				X	
3.1.1.2	ELECTRICAL POWER INTERFACE			X		
3.1.1.3	MECHANICAL INTERFACE				X	
3.1.1.3.1	COOLING			X		
3.1.1.3.2	VIBRATION			X		
3.2	CHARACTERISTICS					X
3.2.1	PERFORMANCE					X
3.2.1.1	OPERATING POWER REQUIREMENTS			X		
3.2.1.1.1	AVERAGE POWER			X		
3.2.1.1.2	POWER CIRCUITS ISOLATION				X	
3.2.1.1.3	ACTIVATION TIME			X		
3.2.1.2	LINEAR ACCELEROMETERS	X				
3.2.1.2.1	AXIS ALIGNMENT				X	
3.2.1.2.2	POLARITY			X		
3.2.1.2.3	OPERATING RANGE			X		
3.2.1.2.4	FREQUENCY RESPONSE			X		
3.2.1.2.5	SENSITIVITY			X		
3.2.1.2.6	CROSS–AXIS SENSITIVITY			X		
3.2.1.2.7	VELOCITY QUANTIZATION		X			
3.2.1.2.8	SCALE FACTOR ACCURACY				X	
3.2.1.2.9	SCALE FACTOR ASYMMETRY				X	
3.2.1.2.10	NULL OFFSETS					X
3.2.1.2.10.1	NULL ACCURACY				X	
3.2.1.2.10.2	NULL VIBRATION SHIFT			X		
3.2.1.2.11	OUTPUT NOISE				X	
3.2.1.3	GYROS	X				
3.2.1.3.1	AXIS ALIGNMENT				X	
3.2.1.3.2	POLARITY			X		
3.2.1.3.3	OPERATING RANGE			X		
3.2.1.3.4	FREQUENCY RESPONSE		X			
3.2.1.3.5	SENSITIVITY		X			
3.2.1.3.6	ANGLE QUANTIZATION		X			
3.2.1.3.7	SCALE FACTOR ACCURACY				X	
3.2.1.3.8	RANDOM WALK				X	
3.2.1.3.9	DRIFT				X	
3.2.1.3.10	G-SENSITIVE BIAS			X		

3.2.1.3.11	VIBRATION SENSITIVE BIAS				X	
	REQUIREMENT	**VERIFICATION METHOD**				
PARAGRAPH NUMBER	**PARAGRAPH TITLE**	**E**	**A**	**D**	**T**	**N/A**
3.2.1.4	BUILT–IN–TEST					X
3.2.1.4.1	TURN–ON BIT		X			
3.2.1.4.2	PERIODIC BIT		X			
3.2.1.4.3	COMMANDED BIT		X			
3.2.2	PHYSICAL CHARACTERISTICS					X
3.2.2.1	WEIGHT	X				
3.2.2.2	DIMENSIONS AND MOUNTING	X				
3.2.2.3	USEFUL LIFE		X			
3.2.3	RELIABILITY		X			
3.2.4	MAINTAINABILITY					X
3.2.4.1	PREVENTIVE MAINTENANCE	X				
3.2.5	ENVIRONMENTAL CONDITIONS					X
3.3	DESIGN AND CONSTRUCTION	X				
3.3.1	MATERIALS, PROCESSES, AND PARTS		X			
3.3.1.1	CORROSION RESISTANCE	X				
3.3.1.2	FUNGUS NUTRIENT	X				
3.3.1.3	DISSIMILAR METALS	X				
3.3.1.4	PROTECTIVE TREATMENT	X				
3.3.1.5	FINISHES	X				
3.3.1.6	PARTS CONTROL PROGRAM					X
3.3.1.6.1	SOLDERING	X				
3.3.1.7	ELECTROSTATIC DISCHARGE PROTECTION	X				
3.3.2	ELECTROMAGNETIC RADIATION					X
3.3.2.1	ELECTROMAGNETIC COMPATIBILITY		X			
3.3.2.2	ELECTROMAGNETIC INTERFERENCE (EMI)		X			
3.3.2.3	GROUNDING AND BONDING		X			
3.3.2.4	MAGNETIC FIELD			X		
3.3.3	NAMEPLATES AND PRODUCT MARKING	X				
3.3.4	WORKMANSHIP	X				
3.3.5	INTERCHANGEABILITY		X			
3.3.6	SYSTEM SAFETY (INCLUDES SUBPARAGRAPHS)		X			
3.3.7	HUMAN FACTORS ENGINEERING	X				
3.3.8	SOFTWARE					X
3.3.8.1	TIME LOADING		X			
3.3.8.2	MEMORY USAGE		X			
3.4	DOCUMENTATION					X
3.5	LOGISTICS		X			

5. PREPARATION FOR DELIVERY

5.1 PRESERVATION, PACKAGING, PACKING. PRESERVATION, PACKAGING, AND PACKING PROCEDURES SHALL COMPLY WITH INTERSTATE COMMERCE COMMISSION RULES AND REGULATIONS AND SHALL ENSURE ARRIVAL AT DESTINATION IN ACCEPTABLE CONDITION. THE ABILITY OF THE IMU TO SATISFY THE REQUIREMENTS OF SECTION 3 HEREIN SHALL NOT BE DEGRADED.

5.2 MARKING FOR SHIPMENT. IN ADDITION TO ANY SPECIAL MARKING REQUIRED BY THE CONTRACT OR PURCHASE ORDER, MARKING FOR SHIPMENT SHALL BE IN ACCORDANCE WITH MIL-STD-129.

6. NOTES

6.1 DEFINITIONS/ACRONYMS

A	AMPS
BIT	BUILT–IN–TEST
BITE	BUILT–IN TEST EQUIPMENT
°C	DEGREES CENTIGRADE
CM	CENTIMETER
CRC	CYCLIC REDUNDANCY CHECK
DB	DECIBEL
°/HR	DEGREES PER HOUR
°/S	DEGREES PER SECOND
EMC	ELECTROMAGNETIC COMPATIBILITY
ES	ELECTROSTATIC SENSITIVE
ESD	ELECTROSTATIC SENSITIVE DEVICE
ESS	ENVIRONMENTAL STRESS SCREENING
°F	DEGREES FAHRENHEIT
F/S	FULL SCALE
g	GRAVITY
HZ	HERTZ
IAW	IN ACCORDANCE WITH
ICD	INTERFACE CONTROL DRAWING
IMU	INERTIAL MEASUREMENT UNIT
KG	KILOGRAM
LISN	LOW IMPEDANCE STABILIZATION NETWORK
LSB	LEAST SIGNIFICANT BIT
MA	MILLIAMPERES
MG	MILLIGRAVITY
MHZ	MEGAHERTZ
MM/S	MILLIMETER PER SECOND
MRAD	MILLIRADIAN
MS	MILLISECOND
MTBF	MEAN TIME BETWEEN FAILURE
MV	MILLIVOLT
MW	MILLIWATT
NGT	NOT GREATER THAN
NLT	NOT LESS THAN
PSD	POWER SPECTRAL DENSITY
PMP	PARTS, MATERIALS AND PROCESSES
POR	POWER ON RESET
PPM	PARTS PER MILLION
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PWB	PRINTED WIRING BOARD
RH	RELATIVE HUMIDITY
RMS	ROOT MEAN SQUARE
SDLC	SYNCHRONOUS DATA LINK CONTROL
SPG	SINGLE–POINT GROUND
SRU	SHOP REPLACEABLE UNIT
T	TIME

UUT	UNIT UNDER TEST
µg	MICRO GRAVITY
V	VOLTS
V DC	VOLTS DIRECT CURRENT

6.2 ANSWERS TO LN-200 CORE IMU USER'S COMMON QUESTIONS

A. POWER:

THE FOUR SIGNAL/POWER RETURNS PINS (C1, D1, D2, K1) ON THE LN-200 IMU'S I/O CONNECTOR ARE ALL CONNECTED TOGETHER IN THE IMU. THEY ARE NOT CONNECTED TO THE CHASSIS GROUND PIN (D3).

THE POWER SUPPLY VOLTAGES SHOULD BE WITHIN THE SPEC BEFORE THE "POWER–ON–RESET*" (G1) INPUT SIGNAL IS REMOVED. THE VERSION 1 IMU'S (P/N 811080) REQUIRE THIS EXTERNAL POR SIGNAL. THE VERSION 2 IMUS (P/N 896900) WILL MAKE THEIR OWN POR WHEN ALL OF THE POWER VOLTAGES ARE IN SPEC. THE EXTERNAL POR SIGNAL IS "ORed" WITH THE INTERNAL POR IN THESE IMU'S.

IF THE VOLTAGES ARE TOO HIGH, DAMAGE TO THE IMU MAY RESULT. IF ANY OF THE VOLTAGES ARE OUT OF SPEC, THE IMU BIT IN THE SERIAL DATA MESSAGE WILL INDICATE ONE OR MORE FAILURES. IF THE "INHIBIT BIT-FAILURE-CAUSED SHUTDOWN" (G3) INPUT SIGNAL IS NOT ASSERTED, THE IMU WILL DISABLE THE GYRO LIGHT SOURCE AND ITS THERMOELECTRIC COOLER/HEATER (TEC), AND REQUEST THAT THE POWER SUPPLY BE SHUTDOWN (H3). ASSERTING THE "POWER-ON-RESET" SIGNAL WILL CLEAR ALL FAILURES.

A COMMON CAUSE OF IMU POWER VOLTAGE PROBLEMS IS THE INITIAL CURRENT DRAWN BY THE TEC TO CONTROL THE TEMPERATURE OF THE LASER DIODE. V1 IMU'S USE -5 VDC TO HEAT, AND +5 VDC TO COOL. V2 IMU'S USE +5 VDC TO BOTH HEAT AND COOL. IF THE VOLTAGE AT THE IMU CONNECTOR DIPS DURING THIS INITIAL HIGH CURRENT (1.4 A FOR THE TEC ALONE), THE IMU FAILS. LONG WIRES AND RATE TABLE SLIP RINGS AGGRAVATE THIS PROBLEM. THE CURE IS TO HOLD THE VOLTAGES AT THE IMU CONNECTOR IN SPEC. THIS MAY REQUIRE ONLY HEAVIER WIRES, OR IT MAY REQUIRE USING A REMOTE SENSE CONNECTION TO THE POWER SUPPLY.

B. DISCRETE I/O:

ALL SINGLE-ENDED OUTPUT SIGNALS CAN DRIVE AT LEAST ONE TTL LOAD. ALL SINGLE-ENDED INPUT SIGNALS HAVE A 4.7K OHM PULL-UP RESISTOR TO +5 VDC, AND A RECEIVER WHICH IS LESS THAN ONE TTL LOAD.

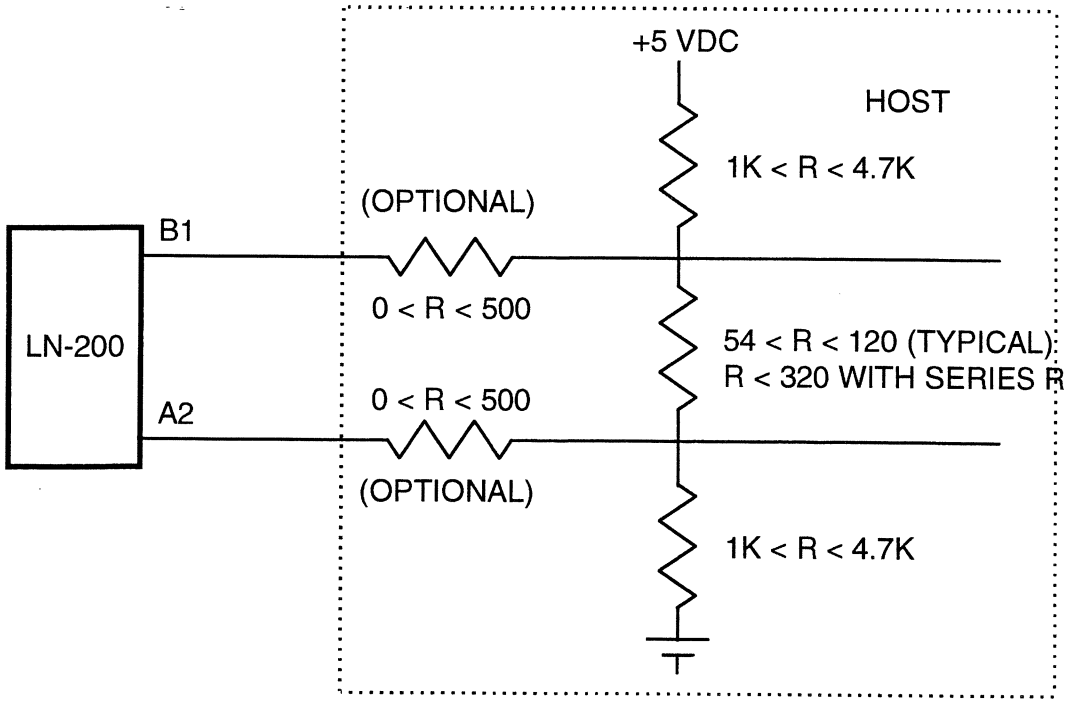
C. SERIAL I/O:

THE CAPABILITY FOR THE CUSTOMER TO CONNECT THESE RESISTORS VIA JUMPERS ON THE I/O CONNECTOR IS PROVIDED BOTH TO TERMINATE THE SERIAL DATA PAIR AT THE IMU (FOR A SHORT TRANSMISSION LINE), AND TO BIAS THE DATA LINES TO A TRUE STATE WHEN ALL TRANSMITTERS ARE DISABLED. FOR LINE LENGTHS GREATER THAN ONE FOOT, THE TERMINATION AND BIASING SHOULD BE AT THE RECEIVER.

THE LN-200 CORE IMU TRANSMITS ITS SIMPLIFIED SDLC SERIAL DATA MESSAGE EVERY 400 Hz. WHEN THE IMU IS NOT TRANSMITTING, ITS TRANSMITTER IS DISABLED (TRI-STATE).

IF THE SERIAL DATA LINES ARE NOT BIASED THERE CAN BE TWO PROBLEMS. ONE IS RECEIVING PHANTOM MESSAGES CAUSED BY NOISE. THE OTHER IS THE FAILURE TO RECOGNIZE AN SDLC OPENING FLAG AS THE START OF A MESSAGE.

THE DATA LINES BEING BIASED TO A TRUE STATE CAUSES AN SDLC ABORT COMMAND (SEVEN CONSECUTIVE ONE-BITS) TO BE RECEIVED WHEN LOOKING FOR AN OPENING FLAG. WITHOUT THIS BIAS, IF A RECEIVER IS ENABLED WHILE A TRANSMITTER IS IN THE MIDDLE OF A MESSAGE, THE RECEIVER WILL MISTAKE THE TRANSMITTER'S CLOSING FLAG AS AN OPENING FLAG. THE RECEIVER WILL NOT BE ABLE TO GET INTO SYNC WITH THE TRANSMITTER, AND WILL NEVER RECEIVE ANY VALID MESSAGES.



LITTON GUIDANCE AND CONTROL SYSTEMS	SIZE A	CAGE CODE 06481	NUMBER 311875	REV AJ
ANY RESTRICTIVE AND / OR NOTICES ON THE SHEET FOR WHICH THIS SHEET SERVES AS A CONTINUATION ARE HEREBY INCORPORATED HERON	SCALE NONE		SHEET 37	

THE "OPTIONAL" SERIES RESISTANCE IS NOT REQUIRED. SOME USERS PREFER THIS CONFIGURATION. IN THAT CASE, THE SERIES RESISTANCE MUST BE BALANCED AND A 1.0 VOLT MINIMUM DIFFERENTIAL MUST BE ESTABLISHED, EX. SERIES R = 500 OHMS, THEN THE TERMINATION RESISTANCE MUST BE RAISED TO 320 OHMS TO PROVIDE A 1.0 VOLT DIFFERENTIAL AT THE LN-200 TRANSCEIVER.

THE "SERIAL DATA CLOCK TERMINATION" (C3) SIGNAL PROVIDES THE CAPABILITY TO TERMINATE THE "SERIAL DATA CLOCK" (B2) AND "SERIAL DATA CLOCK*" (A3) SIGNALS. WHEN PINS C3 AND B2 ARE CONNECTED TOGETHER THERE WILL BE A 120 OHM TERMINATION BETWEEN "SERIAL DATA CLOCK" AND "SERIAL DATA CLOCK*". IT IS PREFERABLE TO TERMINATE THESE SIGNALS AT THE RECEIVING END.

THE "EXTERNAL SYNC TERMINATION" (L1) SIGNAL PROVIDES THE CAPABILITY TO TERMINATE THE "EXTERNAL SYNC" (L2) AND "EXTERNAL SYNC*" (L3) SIGNALS. WHEN PINS L1 AND L2 ARE CONNECTED TOGETHER THERE WILL BE A 120 OHM TERMINATION BETWEEN EXTERNAL SYNC AND EXTERNAL SYNC*.

BECAUSE OF THE RANGE OF TERMINATION SCHEMES AVAILABLE AND THE PERFORMANCE OF OUR TRANSCEIVER, THIS RS485 SDLC IS ALSO RS422 COMPATIBLE.

D. FREQUENCY RESPONSE:

D.1 GYRO

GAIN AND PHASE

THE GYRO GAIN AS A FUNCTION OF FREQUENCY IS:

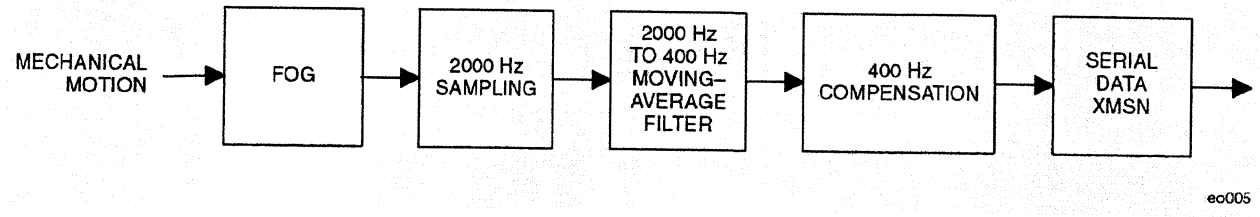
GAIN = {SIN (UF) / (UF)} *{SIN (UF) / 5SIN (UF/5)}

WHERE: F IS FREQUENCY IN HZ
U IS π / (OUTPUT DATA BUS RATE IN HZ)

PHASE = 360° * (GYRO FILTER DELAY + 0.001 SEC) * F

WHERE: F IS FREQUENCY IN HZ
GYRO FILTER DELAY IS 0.00225 SEC FOR 400 HZ RATE, 0.0035 SEC FOR 200 HZ RATE, 0.006 SEC FOR 100 HZ RATE, 0.00725 SEC FOR 80 HZ RATE, AND 0.0051 SEC FOR 10 HZ RATE.

GYRO DATA FLOW FOR 400 HZ OUTPUT DATA RATE



THE FIBER-OPTIC-GYRO HAS A BANDWIDTH > 100 KHZ.

THE MOVING-AVERAGE FILTER OUTPUT IS THE SUM OF THE CURRENT AND FOUR PREVIOUS 2000HZ SAMPLES DIVIDED BY 5. THEN FIVE OF THESE 2000 HZ FILTERED OUTPUTS ARE SUMMED TO MAKE THE 400 HZ OUTPUT. FOR THE 200 HZ OUTPUT, TEN OF THE 2000 HZ OUTPUTS ARE SUMMED. FOR THE 100 HZ OUTPUT, 20 OF THE 2000 HZ OUTPUTS ARE SUMMED; AND SO ON.

THE 400 HZ COMPENSATION AND SERIAL DATA TRANSMISSION DELAY IS < 1.0 MSEC.

D.2 ACCELEROMETER

GAIN AND PHASE

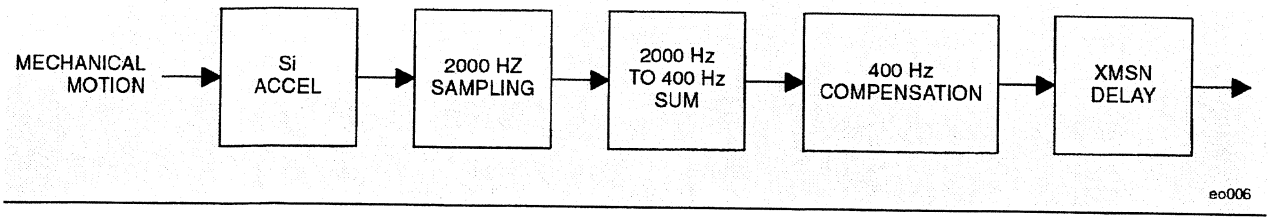
GAIN = SECOND-ORDER GAIN * SIN (UF)/(UF)

WHERE: F IS FREQUENCY IN HZ
U IS π / (OUTPUT DATA BUS RATE IN HZ)

PHASE = SECOND-ORDER PHASE + 360° * (ACCEL SUM DOWN DELAY + 0.001 SEC) * F

WHERE: F IS FREQUENCY IN HZ
ACCEL SUM DOWN DELAY IS 0.00125 SEC FOR 400 HZ RATE, 0.0025 SEC FOR 200 HZ RATE, AND 0.005 SEC FOR 100 HZ RATE.

ACCEL DATA FLOW FOR 400 HZ OUTPUT DATA RATE



THE SILICON ACCELEROMETER HAS A SECOND-ORDER RESPONSE FOR FREQUENCIES ABOVE 10 HZ.

TEMPERATURE (DEG C)	NATURAL FREQUENCY (HZ)	DAMPING FACTOR
-54	160	0.38
+25	130	0.52
+71	100	0.70

THE 2000 HZ TO 400 HZ SUM IS OF THE FIVE MOST-RECENT 2000 HZ SAMPLES.

THE 400 HZ COMPENSATION AND SERIAL DATA TRANSMISSION DELAY IS < 1.0 MSEC.

6.3 LN-200 OPTIONS

AVAILABLE OPTIONS FOR THE LN-200

THE LN-200 HAS VARIOUS FEATURES DESIGNED INTO IT THAT ARE AVAILABLE VIA SOFTWARE SWITCHES. THE DESIRED FEATURE SHOULD BE IDENTIFIED WHEN ORDERING THE UNIT. THESE FEATURES MAY BE ORDERED BY IDENTIFYING THE FEATURE IN THE ORDERED "DASH" NUMBER. 311875-"ABCDEF", WHERE "A" IS FOR THE PERFORMANCE REQUIREMENTS, "B" IS FOR DATA MESSAGE RATE AND SYNCHRONIZATION OPTIONS, "C" IS FOR SOFTWARE VARIANTS, "D" IS FOR HARDWARE VARIANTS, "E" IS FOR DATA CLOCK OPTIONS, AND "F" IS USED FOR GYRO OUTPUT DATA SCALING OPTIONS.

NOTE: OPTIONS A=6, 7, 8, A, AND B ARE NOT AVAILABLE AT THIS TIME.

A. SYSTEM PERFORMANCE SUMMARY FOR 311875-AXXXXX

IMU OPTIONS	A=1	A=2	A=3	A=C	A=D	A=L
IMU OPTIONS LESS ACCELEROMETERS	A=6	A=7	A=8	A=A	A=B	
ACCELEROMETERS						
AXIS MISALIGNMENT, MR, 1σ	0.1	0.3	3.0	0.1	0.3	0.1
SCALE FACTOR ACCURACY, PPM, 1σ	300	1000	5000	300	1000	1000
SCALE FACTOR ASYMMETRY, PPM, 1σ	150	500	2500	150	500	500
NULL ACCURACY (BIAS), μg, 1σ	300	1500	3000	300	1500	1500
NULL VIBRATION SHIFT, $\mu g/g^2$, 1σ	50	50	50	50	50	50
NOISE, μg RMS, 10 SEC INTERVAL	35	35	35	35	35	35
GYRO						
AXIS MISALIGNMENT, MR, 1σ	0.1	0.3	3.0	0.1	0.3	0.1
SCALE FACTOR ACCURACY, PPM, 1σ	100	100	500	300	300	100
DRIFT (BIAS), °/HR, 1σ	1.0	3.0	8	1.0	3.0	1.0
RANDOM WALK, $°/\sqrt{Hr}$	0.07	0.15	0.15	0.07	0.15	0.07
G-SENSITIVE BIAS, °/HR/g, 1σ	0.01	0.01	0.03	0.01	0.01	0.01
VIBRATION SENSITIVE BIAS, $°/HR/g^2$, 1σ	0.02	0.02	0.1	0.02	0.02	0.02

INFORMATION

GYRO BIAS STABILITY IS 0.65°/HR, 1σ, 100 SEC CORRELATION TIME
ACCELEROMETER BIAS STABILITY IS 50μG, 1σ, 60 SEC CORRELATION TIME

SYSTEM PERFORMANCE SUMMARY FOR 311875-EXXXXX

TEST	PARAMETER MEASURED	LIMITS (MAX)
CALIBRATION	GYRO BIAS ERROR	±3°/HR
	GYRO SCALE FACTOR ERROR	±200 PPM
	GYRO MISALIGNMENT	±300μRAD
	ACCEL BIAS ERROR	±3000μg
	ACCEL + SCALE FACTOR ERROR	±1000 PPM
	ACCEL - SCALE FACTOR ERROR	±1000 PPM
	ACCEL SCALE FACTOR ASYMMETRY	±400 PPM
(ACCEL SCALE FACTOR ASYMMETRY IS THE DIFFERENCE BETWEEN THE + SCALE FACTOR ERROR AND THE - SCALE FACTOR ERROR DIVIDED BY 2.)		
	ACCEL MISALIGNMENT	±300μRAD
GYRO SCALE FACTOR X,Y,Z GYRO OUTPUT		
	±10°/SEC	±0.003°/SEC
	±50°/SEC	±0.01°/SEC
	±200°/SEC	±0.04°/SEC
	GYRO SCALE FACTOR ASYMMETRY	±100PPM
(GYRO SCALE FACTOR ASYMMETRY IS THE DIFFERENCE BETWEEN THE ABSOLUTE VALUE OF THE MEASUREMENT AT +200°/SEC AND -200°/SEC MULTIPLIED BY 5000.)		
QUIESCENT NOISE	DELTA THETA	4.2°/HR
	DELTA VELOCITY (1.0 SEC)	200μg
	DELTA VELOCITY (10 SEC)	35μg
	DELTA VELOCITY (30 SEC)	20μg
	DELTA VELOCITY TREND	±0.2μg/SEC
TEMP CYCLE	X,Y,Z DELTA THETA	±3.0°/HR
	X,Y,Z DELTA VELOCITY	±3000μg
WORKMANSHIP VIBRATION		
	X,Y,Z DELTA THETA	±3.0°/HR AT 7 GRMS IN AXIS (±3.0°/HR AT 11 GRMS SKEW)
	X,Y,Z DELTA VELOCITY	±2450 μg AT 7 GRMS IN AXIS (±2450μg AT 11 GRMS SKEW)
GROUND ISOLATION	RESISTANCE	>1.0 MEGOHM

NOTE: ±LIMIT MEANS THAT A MEASURED VALUE IS GREATER THAN OR EQUAL TO THE -LIMIT AND IS LESS THAN OR EQUAL TO THE +LIMIT

SYSTEM PERFORMANCE SUMMARY FOR 311875-FXXXXX

IMUs FOR THIS REQUIREMENT MUST MEET THE 311875-1XXXXX PERFORMANCE AND PASS A GYRO FIGURE OF MERIT FOR EACH GYRO.

FROM THE ESS HOT AND COLD GYRO BIAS SHIFT DATA COMPUTE THE AVERAGE AND STANDARD DEVIATION FOR THE FIVE HOT VALUES AND THE FIVE COLD VALUES.

THE LARGEST OF THE HOT AND COLD ESS BIAS SHIFT AVERAGE IS $T_{i\,ave\,max}$.

THE AVERAGE OF THE HOT AND COLD STANDARD DEVIATION, $\sigma_{i\,T} = \frac{1}{2}(\sigma_{i\,cold} + \sigma_{i\,hot})$, IS $\sigma_{i\,T}$.

THE ESS VIBRATION GYRO BIAS SHIFT AT $0.025g^2/Hz$ IS V_i.

WHERE i = X, Y, Z

COMPUTE THE FOLLOWING VALUE FOR EACH GYRO:

$$P_i^2 = [\,|V_i| + |T_{i\,ave\,max}|\,]^2 + [\,3\sigma_{i\,T}\,]^2$$

THE VALUE OF P_i MUST BE LESS THAN OR EQUAL TO 3.6°/Hr FOR ALL GYROS TO MEET THIS PERFORMANCE CRITERIA.

SYSTEM PERFORMANCE SUMMARY FOR 311875-GXXXXX

TEST	PARAMETER MEASURED	LIMITS (MAX)
CALIBRATION	GYRO BIAS ERROR	±3°/HR
	GYRO SCALE FACTOR ERROR	±200 PPM
	GYRO MISALIGNMENT	±300μRAD
	ACCEL BIAS ERROR	±3000μg
	ACCEL + SCALE FACTOR ERROR	±1000 PPM
	ACCEL - SCALE FACTOR ERROR	±1000 PPM
	ACCEL SCALE FACTOR ASYMMETRY	±400 PPM
(ACCEL SCALE FACTOR ASYMMETRY IS THE DIFFERENCE BETWEEN THE + SCALE FACTOR ERROR AND THE - SCALE FACTOR ERROR DIVIDED BY 2.)		
	ACCEL MISALIGNMENT	±300μRAD
GYRO SCALE FACTOR X,Y,Z GYRO OUTPUT		
	±10°/SEC	±0.003°/SEC
	±50°/SEC	±0.01°/SEC
	±200°/SEC	±0.04°/SEC
	GYRO SCALE FACTOR ASYMMETRY	±100PPM
(GYRO SCALE FACTOR ASYMMETRY IS THE DIFFERENCE BETWEEN THE ABSOLUTE VALUE OF THE MEASUREMENT AT +200°/SEC AND -200°/SEC MULTIPLIED BY 5000.)		
QUIESCENT NOISE	DELTA THETA	4.2°/HR
	DELTA VELOCITY (1.0 SEC)	200μg
	DELTA VELOCITY (10 SEC)	35μg
	DELTA VELOCITY (30 SEC)	20μg
	DELTA VELOCITY TREND	±0.2μg/SEC
TEMP CYCLE	X,Y,Z DELTA THETA	±3.0°/HR
	X,Y,Z DELTA VELOCITY	±3000μg
WORKMANSHIP VIBRATION		
	X,Y,Z DELTA THETA	±3.0°/HR AT 7 GRMS IN AXIS (±3.0°/HR AT 11 GRMS SKEW)
	X,Y,Z DELTA VELOCITY	±1715 μg AT 7 GRMS IN AXIS (±1412 μg AT 11 GRMS SKEW)
GROUND ISOLATION	RESISTANCE	>1.0 MEGOHM

NOTE: ±LIMIT MEANS THAT A MEASURED VALUE IS GREATER THAN OR EQUAL TO THE -LIMIT AND IS LESS THAN OR EQUAL TO THE +LIMIT

POWER SEQUENCING:

ALL POWER FORMS (EXCEPT THE +15V) MUST BE WITHIN ±10% OF THEIR SPECIFICATION VALUE WITHIN 0.004 SECONDS IF THE +15V IS ABOVE +3.0V.

THE +15V MUST BE BELOW +3.0V WITHIN 0.020 SECONDS IF ANY OF THE OTHER POWER FORMS DROP BELOW 10% OF THEIR SPECIFICATION VALUE.

B. DATA MESSAGE RATE 311875-XBXXXX

B=0	400Hz I/O RATE, NO EXTERNAL SYNC (NORMAL)
B=1	400Hz I/O RATE, EXTERNAL SYNC ENABLED
B=2	200Hz I/O RATE, NO EXTERNAL SYNC
B=3	200Hz I/O RATE, EXTERNAL SYNC ENABLED
B=4	100Hz I/O RATE, NO EXTERNAL SYNC
B=5	100Hz I/O RATE, EXTERNAL SYNC ENABLED
B=6	80Hz I/O RATE, NO EXTERNAL SYNC
B=7	80Hz I/O RATE, EXTERNAL SYNC ENABLED (**NOT AVAILABLE AT THIS TIME**)
B=8	10Hz I/O RATE, NO EXTERNAL SYNC
B=9	10Hz I/O RATE, EXTERNAL SYNC ENABLED (**NOT AVAILABLE AT THIS TIME**)
B=A	2000Hz GYRO OUTPUT, NO ACCELEROMETER OUTPUT, 4 WORD MESSAGE. SEE 3.1.1.1. **FOR THIS OPTION, C=7. NOTE: ACCELEROMETERS ARE ON THE IMU BUT OUTPUTS ARE NOT AVAILABLE.**
B=N	NOT APPLICABLE

C. IMU VARIATIONS, 311875-XXCXXX

C=0	NORMAL
C=1	AMRAAM INTERFACE **(FOR THIS OPTION, B = N, E IS BLANK, AND F IS BLANK. SEE 6.6 FOR ADDITIONAL INFORMATION)**
C=2	FILTERED RATE OUTPUTS 13 WORD MESSAGE. SEE 3.1.1.1
C=3	3840Hz GYRO OUTPUT, NO ACCEL OUTPUT **(FOR THIS OPTION, B = N AND F IS BLANK)**
C=4	3600Hz GYRO OUTPUT, 360Hz ACCEL OUTPUT **(FOR THIS OPTION, B = N AND F IS BLANK)**
C=6	10 WORD DATA MESSAGE
C=7	4 WORD GYRO MESSAGE. NO ACCELEROMETER DATA. SEE 3.1.1.1
C=8	360 HZ GYRO, 360 HZ ACCELEROMETER OUTPUT, 8 WORD MESSAGE, NRZ OUTPUT FORMAT **(FOR THIS OPTION B=N, E IS BLANK AND F IS BLANK).**
C=9	**OVERMODULATION (FOR THIS OPTION, THE SPECIFICATION FOR MAXIMUM THRESHOLD, PAR 3.2.1.3.5, IS WAIVED).**
C=A	COMBINATION OF C=3 AND C=9 **(FOR THIS OPTION B=N).**
C=B	COMBINATION OF C=4 AND C=9 **(FOR THIS OPTION B=N).**
C=C	FILTERED LINEAR ACCELERATIONS, 16 WORD MESSAGE
C=D	APPLICABLE FOR ALTERNATE SOFTWARE PROGRAM WITH AVAILABLE OPTIONS. **(FOR THIS OPTION B=N)**
C=E	APPLICABLE FOR ALTERNATE SOFTWARE PROGRAM WITH AVAILABLE OPTIONS. **(FOR THIS OPTION B=N).**

D. IMU HARDWARE VARIANTS, 311875-XXXDXX

D=1 STANDARD PRODUCTION HARDWARE (LN-200)

D=2 INTERNAL DATA BUS ELECTRICAL BIASING 150 OR 200 METER GYROS

D=G ACCELEROMETER DATA VALID AT 500 MS

D=T INTERNAL DATA BUS ELECTRICAL BIASING 200 METER GYROS ONLY

311875-EXX1XX IS OBSOLETE FOR FUTURE BUILDS; NO LONGER PROCURABLE.

E. DATA CLOCK OPTIONS, 311875-XXXXEX

E=BLANK NORMAL

E=0 NORMAL, USED WHEN F IS NOT BLANK

E=1 EXTERNAL CLOCK

E=2 2 mHz INTERNAL CLOCK

E=3 4 mHz INTERNAL CLOCK (**NOT AVAILABLE AT THIS TIME**)

F. GYRO OUTPUT DATA SCALING OPTIONS, 311875-XXXXXF

GYRO SCALING AND UNITS

F	SCALING, rad	LSB, rad	LSB, arc-sec	COMMENTS
1	B1.14	1/16384	12.589	high-rate, low accuracy applications
2	B0.15	1/32768	6.295	high-rate, low accuracy applications
3	B-1.16	1/65536	3.1475	high-rate, low accuracy applications
4 BLANK FOR B = 4, 5, 6, 7	B-2.17	1/131072	1.5737	standard LN-200 gyro output at 100 Hz and 80 Hz
5 BLANK FOR B = 2, 3	B-3.18	1/262144	0.7868	standard LN-200 gyro output at 200 Hz
6 BLANK FOR B = 0, 1, 8, 9	B-4.19	1/524288	0.3934	standard LN-200 gyro output at 400 Hz and 10 Hz
7	B-5.20	1/1048576	0.1967	use for applications < 700° /s at 400Hz
8	B-6.21	1/2097152	0.09835	use for applications < 350° /s at 400Hz
9 BLANK FOR B = A	B-7.22	1/4194304	0.04918	standard LN-200 gyro output at 2000 Hz
A	B-8.23	1/8388608	0.02459	very low rate applications < 85 ° /s at 400Hz
B	B-9.24	1/16777216	0.01229	very low rate applications < 40 ° /s at 400Hz
C	B-10.25	1/33554432	0.006147	very low rate applications < 20 ° /s at 400Hz
D	B-11.26	1/67108864	0.003074	very low rate applications < 10 ° /s at 400Hz
E	B-12.27	1/134217728	0.001537	low rate applications < 27° /s at 2000Hz
F	B-13.28	1/268435456	0.0007684	low rate applications < 13° /s at 2000Hz

NOTE: THIS OPTION IS FOR GYRO DATA ONLY. THE ACCELEROMETER SCALING IS PER TABLE II. IT CHANGES WITH DATA RATEONLY; NOT WITH THIS OPTION.

GYRO RANGE AND RESOLUTION

F = X Range, °/s resolution, °/hr	OUPUT DATA RATE					
	2000Hz	400Hz	200Hz	100Hz	80Hz	10Hz
1	N/A	N/A	N/A	11459°/s	9167°/s	N/A
	N/A	N/A	N/A	1259°/Hr	1008°Hr	N/A
2	N/A	N/A	11459°/s	5729°/s	4583°/s	N/A
	N/A	N/A	1259°/Hr	630°/Hr	504°/Hr	N/A
3	N/A	11459°/s	5729°/s	2864°/s	2291°/s	N/A
	N/A	1259°/Hr	630°/Hr	315°/Hr	252°/Hr	N/A
4 or	N/A	5729°/s	2864°/s	**1432°/s**	**1145°/s**	N/A
BLANK FOR B = 4, 5, 6. 7	N/A	630°/Hr	315°/Hr	**158°/Hr**	**126°/Hr**	N/A
5 or	N/A	2864°/s	**1432°/s**	716°/s	572°/s	N/A
BLANK FOR B = 2, 3	N/A	315°/Hr	**158°/Hr**	79°/Hr	63°/Hr	N/A
6 or	N/A	**1432°/s**	716°/s	358°/s	286°/s	**35°/s**
BLANK FOR B = 0, 1, 8, 9	N/A	**158°/Hr**	79°/Hr	40°/Hr	32°/Hr	**4°/Hr**
7	N/A	716°/s	358°/s	179°/s	143°/s	17°/s
	N/A	79°/Hr	40°/Hr	20°/Hr	16°/Hr	2°/Hr
8	1790°/s	358°/s	179°/s	89°/s	71°/s	8°/s
	197°/Hr	40°/Hr	20°/Hr	10°/Hr	8°/Hr	1°/Hr
9 or	**859°/s**	179°/s	89°/s	44°/s	35°/s	4°/s
BLANK FOR B = A	**99°/Hr**	20°/Hr	10°/Hr	5°/Hr	4°/Hr	0.5°/Hr
A	447°/s	89°/s	44°/s	22°/s	17°/s	2°/s
	50°/Hr	10°/Hr	5°/Hr	3°/Hr	2°/Hr	0.25°/Hr
B	223°/s	44°/s	22°/s	11°/s	8°/s	1°/s
	25°/Hr	5°/Hr	3°/s	2°/Hr	1°/Hr	0.13°/Hr
C	111°/s	22°/s	11°/s	N/A	N/A	0.5°/s
	13°/Hr	3°/Hr	2°/Hr	N/A	N/A	0.07°/Hr
D	55°/s	11°/s	N/A	N/A	N/A	0.3°/s
	7°/Hr	2°/Hr	N/A	N/A	N/A	0.04°/Hr
E	27°/s	N/A	N/A	N/A	N/A	N/A
	4°/Hr	N/A	N/A	N/A	N/A	N/A
F	13°/s	N/A	N/A	N/A	N/A	N/A
	1.6°/Hr	N/A	N/A	N/A	N/A	N/A

NOTE 1: F IS **BLANK** FOR THE **BOLD** DEFAULT DATA RATES.

NOTE 2: THE DELTA THETA REASONABLENESS BIT TEST LIMIT IS SET TO THE RATE RANGE IN THE TABLE EXCEPT FOR THE STANDARD 400Hz, 200Hz, AND 100Hz OUTPUT RANGE OF 1432°/s AND THE 11549°/s RANGE FOR 400Hz, 200Hz, AND 100Hz. FOR THESE RATES, THE BIT LIMIT IS 1360°/s AND 10971°/s RESPECTIVELY.

NOTE3: RATE VALUES IN THE TABLE ARE TRUNCATED. RESOLUTION VALUES ARE ROUNDED UP. USE THE FOLLOWING TO CALCULATE EXACT VALUES:

CALCULATIONS FOR RANGE AND RESOLUTION

RANGE IS LSB*2^15*DATA RATE
EXAMPLE: STANDARD 400Hz OUTPUT DATA RATE AND DEFAULT SCALING OF B-4.19 GYRO RANGE IS (1/524288)*32768*400 r/s OR 1432.39°/s.

RESOLUTION IS LSB*DATA RATE
EXAMPLE: STANDARD 200Hz OUTPUT DATA RATE AND DEFAULT SCALING OF B-3.18 RESOLUTION IS (1/262144)*200 r/s OR 157.37°/Hz.

6.4 OTHER DATA MESSAGES

311875-XX4XXX 3600Hz GYRO DATA OUTPUT MESSAGE

WORD	CONTENTS	UNITS, SCALING
1	3600Hz DELTA X	RAD, B-9.24
2	3600Hz DELTA Y	RAD, B-9.24
3	3600Hz DELTA Z	RAD, B-9.24
(RANGE 402.9°/SEC, 44.3°/HR RESOLUTION)		
4	MAIN FAILURE WORD	
5	IMU MODE IN 8 MSB, MUX DATA WORD ID IN 8 LSB	
6	MULTIPLEXED DATA WORD	SEE BELOW
7	CHECK SUM	
MULTIPLEXED DATA WORD		
0	360Hz DELTA VELOCITY X	M/SEC, B1.14
1	360Hz DELTA VELOCITY Y	M/SEC, B1.14
2	360Hz DELTA VELOCITY Z	M/SEC, B1.14
3,4,5	X,Y,Z GYRO TEMPERATURE	°C, B7.8
6,7,8	X,Y,Z ACCEL TEMPERATURE	°C, B7.8
9	LASER DIODE TEMPERATURE	°C, B7.8
10	360Hz DELTA VELOCITY X	M/SEC, B1.14
11	360Hz DELTA VELOCITY Y	M/SEC, B1.14
12	360Hz DELTA VELOCITY Z	M/SEC, B1.14
13	OPTICAL RECEIVER TEMP	°C, B7.8
14	BFS TEMP	°C, B7.8
15,16	-5VDC, +5VDC	7VDC, B0.15

311875-XX4XXX 3600Hz GYRO DATA OUTPUT MESSAGE

WORD	CONTENTS	UNITS, SCALING
17,18	-15VDC, +15VDC	20VDC, B0.15
19	ANALOG GROUND	3VDC, B0.15
20	360Hz DELTA VELOCITY X	M/SEC, B1.14
21	360Hz DELTA VELOCITY Y	M/SEC, B1.14
22	360Hz DELTA VELOCITY Z	M/SEC, B1.14
23,24,25,26,27,28,29	DETAILED FAILURE WORD	0,1,2,3,4,5,6
30	360Hz DELTA VELOCITY X	M/SEC, B1.14
31	360Hz DELTA VELOCITY Y	M/SEC, B1.14
32	360Hz DELTA VELOCITY Z	M/SEC, B1.14
33,34,35,36,37,38,39	DETAILED FAILURE WORD	7,8,9,10,11,12,13

6.5 N/A

6.6 AMRAAM INTERFACE OPTION, C = 1, B = N, E AND F ARE BLANK.

A. AXIS DEFINITION

FOLLOWING IS THE RELATION BETWEEN THE LN-200 AXES SHOWN IN FIG. 3 AND THE AMRAAM IRU AXES:

LN-200	AMRAAM AXES
X	-Y
Y	-Z
Z	+X

B. CONNECTOR PIN CROSS REFERENCE FOR AMRAAM INTERFACE

LN-200 Pin No.	AMRAAM Pin No.	LN-200 Description	AMRAAM DESCRIPTION
A2	13	SERIAL DATA*	SERIAL DATA*
A3	17	SERIAL DATA CLOCK*	DATA SHIFT CLOCK*
B1	14	SERIAL DATA	SERIAL DATA
B2	18	SERIAL DATA CLOCK	DATA SHIFT CLOCK
C1	8	SIGNAL/POWER GND No. 1	5 V RTN
C2 **OPTION**		INHIBIT*INTERNAL POR	
D1	19	SIGNAL POWER GND No. 2	35 V RTN
D2	21	SIGNAL POWER GND No. 3	15 V RTN
D3	6	CHASSIS GND	CHASSIS GND

LN-200 Pin No.	AMRAAM Pin No.	LN-200 Description	AMRAAM DESCRIPTION
E1	7	+5 VDC POWER No. 1	+5 VDC
E2		+5 VDC POWER No. 2	
E3		+5 VDC POWER No. 3	
F1 **OPTION**		-5 VDC POWER, OPEN FOR INTERNAL -5 VDC	
F2 **OPTION**		-5 VDC POWER SENSE, OPEN FOR INTERNAL -5 VDC	
F3	22	+15 VDC POWER	+15 VDC
G1 **OPTION**		POWER-ON-RESET	
G2	20	-15 VDC POWER	-15 VDC
H2		TIME-OUT COUNTER FAIL	
J2	2	DO NOT EXECUTE COMMANDED BIT	BIT ENABLE
K1	23	SIGNAL/POWER GND No. 4	5 V RTN
K2	1	RESERVED,DO NOT DISABLE SERIAL I/O	RESERVED
L2	28	EXTERNAL SYNC (INPUT)	DATA SYNC (OUTPUT)
L3	29	EXTERNAL SYNC* (INPUT)	DATA SYNC* (OUTPUT)
M1	30	END OF OUTPUT DATA SAMPLING*	SYNC CLOCK*
M2	15	END OF OUTPUT DATA SAMPLING	SYNC CLOCK

NOTE: ONLY THE LN-100 PINS THAT REQUIRE CONNECTION ARE SHOWN. SOME ARE OPTIONAL. NOT ALL THE AMRAAM INTERFACE CONNECTIONS ARE USED.

AMRAAM SIGNALS NOT USED BY THE LN-200. MOST ARE FOR THE SEEKER GYRO SPIN MOTOR.

AMRAAM Pin No.	DESCRIPTION
3	SPIN MOTOR INHIBIT
4	-35 VDC
5	+35 VDC
9	PHASE I
10	PHASE II
11	NEUTRAL
12	SPARE
16	SPARE
25	RESERVED
26	SPARE
27	SPARE

APPROVED SOURCE(S) OF SUPPLY

IDENTIFICATION OF THE APPROVED SOURCE(S) OF SUPPLY HEREON IS NOT TO BE CONSTRUED AS A GUARANTEE OF PRESENT OR CONTINUED AVAILABILITY AS A SOURCE OF SUPPLY FOR THE ITEM DESCRIBED ON THE DRAWING.

DASH NO.	VENDOR PART NO.	VENDOR NAME	VENDOR CAGE CODE OR ADDRESS
XXX1	896900-0001	LITTON SYSTEMS INC GUIDANCE & CONTROL SYSTEMS INC	06481
XXX2	896900-0002	LITTON SYSTEMS INC GUIDANCE & CONTROL SYSTEMS INC	06481
XXX2	898300-0001	LITTON SYSTEMS INC GUIDANCE & CONTROL SYSTEMS INC	06481
XXXT	898350-0001	LITTON SYSTEMS INC GUIDANCE & CONTROL SYSTEMS INC	06481

NOTE: 311875-XXX2 IS A SUBSTITUTABLE ITEM FOR 311875-XXX1

LITTON **GUIDANCE AND CONTROL SYSTEMS**	SIZE A	CAGE CODE 06481	NUMBER 311875	REV AJ
ANY RESTRICTIVE AND / OR NOTICES ON THE SHEET FOR WHICH THIS SHEET SERVES AS A CONTINUATION ARE HEREBY INCORPORATED HERON	SCALE NONE		SHEET 50	