B R O O K H A V E N N A T I O N A L L A B O R A T O R Y

A. G. S. D E P T.

M A I N T E N A N C E M A N U A L

LTB INSTRUMENTATION CONTROLLER

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1.0 Safety Considerations.

1.1 Hazardous circuits - The LTB Instrumentation controller contains 110 vac circuits within the enclosed chassis. A warning sign is posted on the outside of the controller bucket. Only qualified knowledgeable personnel should open the controller bucket.

1.2 Fans - There are three fans with exposed blades inside the controller bucket.

1.3 Remote equipment - The LTB Instrument controller has internal circuits and exposed fan blades which can be considered hazardous but it also controls remote equipment that could cause harm to personnel. The device operates instrumentation plungers which could be undergoing maintenance. These devices should be in the local mode at these times but anybody wishing to operate the controller via computer should be aware of any maintenance work in the area.

2.0 General Description

2.1 Purpose of Equipment - The LTB instrumentation controller controls and reports the status of all the beam instrumentation in the LTB line. The controller also digitizes signals from the various instruments and reports the data to programs running on the various control consoles. The controller provides the timing needed by the LTB instruments.

2.2 Functional description -

The LTB instrument controller supports the following LTB transfer line instrumentation and Booster ring instrumentation.

1. LTB instrumentation
   A. 2 Harp profile monitors
   B. 2 Beam current transformers
   C. Maximum of 8 stripline BPMs
2. Booster ring instrumentation.
   A. Booster Circulating Beam Monitor (BCBM)
   B. Booster Injection Beam Monitor

Each harp has an SLD to insert or retract the device. A Harp that has been requested to insert or retract does so after the Booster Group End code so the harp body does not interfere with the beam.

NOTE: The harps require 400 ms to fully insert or retract. Therefore no beam can be present for that amount of time after EOG .

There are SLD's to set the gain for polarized or nonpolarized beam, harp electronics gain, Transformer gain, BCBM gain, and BPM gain and an SLD to set the beam type. When a data report request is received the controller waits unit the next occurrence of User reset that was indicated in the request for data and report the data taken from the next prepulse until the next

occurrence of EOG. The data request CLD's contain the number of reports requested. The controller keeps track of the number of reports remaining and if two or more requests are received from the same user the number of reports remaining will always be the largest number. If the number of reports requested = FFh then the controller reports data until a request is sent requesting zero reports.

Timing for data acquisition is as follows.

At PrePulse the various gains and beam time sample times are set up for the user requested in preparation for the injection and acceleration phases of the booster cycle. All integrate times and sample times for beam time data are from Booster Injection(Peaker). The LTB electronics includes 3 Multiplexer Control units. Two for the Harps measurement and the other to read all the other LTB line instruments and the two Booster ring transformer signals. The LTB harp data is acquired by reading the two harp scanners after the booster injection phase. When the acceleration phase of the booster cycle is complete then the BPM's, LTB transformers, the BIBM's and the BCBM's data is acquired by reading the third scanner. Harp data is only reported as valid if the harp is fully inserted or fully retracted when the data is taken. If the harp is not fully inserted or retracted at the beginning of a cycle then the data field , for that cycle, contain zeros.

During Heavy Ion injection LTB instrument data is not taken.

Calibration of the BIBMs , the BCBMs, and the BPMs takes place during the time when the beam is normally present except the beam will be turned off by operations.

2.3 Specifications -

2.3.1 Digital signals - All digital outputs and inputs for the LTB Instrumentation controller are TTL level signals.

2.3.2 Analog input signals - All analog signals are in the range of +/- 10 V. Resolution D/A is 11 bits + sign.

2.3.3 Connectors -

Digital I/O connectors are 3 female 50 pin Scotch Delta Ribbon connectors.

Analog connectors are 2 male 50 pin Scotch Ribbon connectors.

Relway connectors are standard IEEE - 488 connectors

2.4 Print Numbers

2.4.1	LTB Instrument controller interface card.	
2.4.2	LTB Instrument controller chassis wiring.	
2.4.5	LTB Instrumentation controller rear panel.	D09 - M - 612
2.4.6	PP Linac Timer Card	D09 - E - 1527
2.4.7	Booster Multibus 1 Receiver/Decoder	D36 - E - 360

3.0 Operating Instructions

3.1 Reference Guide

LTB Instrumentation Controller

WARNING

Operation of the LTB Instrumentation controller causes beam instruments to move in and out of the beam.

Resetting the controller will result in all devices returning to initialized values. All instruments will be withdrawn and all timer values will return to default values. All requests for data reports will be canceled.

Electrical feed - 110vac

Station

Combox

Service Group - Accelerator Controls Section

Turn off procedure - turn off circuit breaker on rear panel.

Turn on procedure - check that all timing, ribbon cables and IEEE - 488 cables are connected and turn circuit breaker on rear panel on. Make sure equipment controlled by the controller is ready.

Reset Procedure - The LTB Instrumentation controller can be reset by pushing the left most reset button on the rear panel. The right button will only reset the control section. See warning about resetting above.

3.2 Preturn on procedure - check that the timing cables are connected. Check that all digital I/O and analog input ribbon cables are connected. Check that the IEEE -488 cable to the station is connected.

3.3 Local turn on/ off procedure - The LTB Instrumentation controller is turned on and off by the circuit breaker on the rear panel.

4.0 Performance tests

4.1 Equipment required

4.1.1 Apollo node running spread sheet and configure

4.1.2 Gaussline and Real-time lines.

4.1.3 Digital voltmeter

4.1.4 Calibrator Datel DVC 8500A

4.1.5 Scope

4.1.6 LTB instrument controller I/O documentation (see below)

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DIGITAL I/O ASSIGNMENTS AND TIMING SIGNAL
I/O FOR LTB
INSTRUMENTATION CONTROLLER

Digital I/O 519 - logic board interface

FUNCTION	519 Pin #	Int. Card	Port	Bit	
Harp 1 Command	J1 - 48	J1 - 47	1	0	Port 1 = output
Harp 2 Command	J1 - 46	J1 - 45	1	1	
Start Scan	J1 - 44	J1 - 43	1	2	
Calibrate	J1 - 42	J1 - 41	1	3	
HI/Protons	J1 - 40	J1 - 39	1	4	
Done reset 1	J1 - 38	J1 - 37	1	5	
Done reset 2	J1 - 36	J1 - 35	1	6	
Data Ready	J1 - 34	J1 - 33	1	7	
EOC Status	J1 - 16	J1 - 15	2	0	Port 2 = input
Spare	J1 - 14	J1 - 13	2	1	
Spare	J1 - 12	J1 - 11	2	2	

Spare	J1 - 10	J1 - 9	2	3
Spare	J1 - 8	J1 - 7	2	4
Spare	J1 - 6	J1 - 5	2	5
Spare	J1 - 4	J1 - 3	2	6
Spare	J1 - 2	J1 - 1	2	7
Spare	J1 - 24	J1 - 23	3	0
Spare	J1 - 22	J1 - 21	3	1
Spare	J1 - 20	J1 - 19	3	2
Spare	J1 - 18	J1 - 17	3	3
Spare	J1 - 26	J1 - 25	3	4
Spare	J1 - 28	J1 - 27	3	5
Spare	J1 - 30	J1 - 29	3	6
Spare	J1 - 32	J1 - 31	3	7

NOTE: 519 J1 odd pins are gnd and interface card J1 even pins are gnd.

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Digital Out - 1 519 board - rear panel DO - 1 interface
DO - 1 is a 50 Pin female 3M Delta Ribbon connector #3565-1000

FUNCTION	519 Pin #	IC Pin #	Port	Bit
Spare	J2 - 48	DO-1 24	4	0
Spare	J2 - 46	DO-1 23	4	1
Spare	J2 - 44	DO-1 22	4	2
Spare	J2 - 42	DO-1 21	4	3
Spare	J2 - 40	DO-1 20	4	4
Spare	J2 - 38	DO-1 19	4	5
Spare	J2 - 36	DO-1 18	4	6
Spare	J2 - 34	DO-1 17	4	7
LTB Xfmr Gain	J2 - 16	DO-1 8	5	0
Harp Gain bit 2	J2 - 14	DO-1 7	5	1
Harp Gain Bit 1	J2 - 12	DO-1 6	5	2
Polarized Gain	J2 - 10	DO-1 5	5	3
BPM Cal/Test cmd 3	J2 - 8	DO-1 4	5	4
BPM Cal/Test Cmd 2	J2 - 6	DO-1 3	5	5
BPM Cal/Test Cmd 1	J2 - 4	DO-1 2	5	6
BPM Gain	J2 - 2	DO-1 1	5	7
BCBM Test Mode	J2 - 24	DO-1 12	6	0
BCBM Cal Pol +	J2 - 22	DO-1 11	6	1
BCBM Cal	J2 - 20	DO-1 10	6	2
BCBM Gain Range B	J2 - 18	DO-1 9	6	3
Int. Gain	J2 - 26	DO-1 13	6	4
Spare	J2 - 28	DO-1 14	6	5
Spare	J2 - 30	DO-1 15	6	6
Spare	J2 - 32	DO-1 16	6	7

NOTE: 519 J2 odd pins are gnd. DO1 pins 26 - 50 are gnd.

Digital In - 1 519 board - rear panel DIN - 1 interface
DIN - 1 is a 50 Pin 3M Delta ribbon connector #3565-1000

FUNCTION	519 Pin #	IC Pin #	Port	Bit
Spare	J3 - 48	DIN-1 24	7	0
Spare	J3 - 46	DIN-1 23	7	1
Spare	J3 - 44	DIN-1 22	7	2
Spare	J3 - 42	DIN-1 21	7	3

Spare	J3 - 40	DIN-1 20	7	4
Spare	J3 - 38	DIN-1 19	7	5
Spare	J3 - 36	DIN-1 18	7	6
Spare	J3 - 34	DIN-1 17	7	7
Rack 2 PS Status	J3 - 16	DIN-1 8	8	0
Rack 2 Local/Remote	J3 - 14	DIN-1 7	8	1
Harp 2 Out	J3 - 12	DIN-1 6	8	2
Harp 2 in	J3 - 10	DIN-1 5	8	3
Rack 1 PS Status	J3 - 8	DIN-1 4	8	4
Rack 1 Local/Remote	J3 - 6	DIN-1 3	8	5
Harp 1 Out	J3 - 4	DIN-1 2	8	6
Harp 1 In	J3 - 2	DIN-1 1	8	7
BCBM Test	J3 - 24	DIN-1 12	9	0
BCBM Cal	J3 - 22	DIN-1 11	9	1
Rack 3 PS Status	J3 - 20	DIN-1 10	9	2
Rack 3 Local/Remote	J3 - 18	DIN-1 9	9	3
BCBM Range A Status	J3 - 26	DIN-1 13	9	4
BCBM Range B Status	J3 - 28	DIN-1 14	9	5
Spare	J3 - 30	DIN-1 15	9	6
Spare	J3 - 32	DIN-1 16	9	7

NOTE: 519 J3 odd pins are gnd. DIN pins 26 - 50 are gnd.

Logic board - conditioned digital outputs - rear panel DO - 2
DO - 2 is a 50 Pin 3M Delta ribbon connector #3565-1000

FUNCTION	Int. Card	I.C. PIN #
Harp Int Start	J2 - 1	DO-2 1
Harp Int. Stop	J2 - 3	DO-2 2
Int. Reset	J2 - 5	DO-2 3
Start Scan	J2 -7	DO-2 4
Advance	J2 - 9	DO-2 5
Cal Trigger	J2 - 11	DO-2 6
BLR Gate	J2 - 13	DO-2 7
INT DLAW (Int. Delay)	J2 - 15	DO-2 8
INT WIDTHW (Int. stop)	J2 - 17	DO-2 9
BIBM 1 Sample Time	J2 - 19	DO-2 10
BIBM 2 Sample Time	J2 - 21	DO-2 11
BIBM 3 Sample Time	J2 - 23	DO-2 12
BIBM 4 Sample Time	J2 - 25	DO-2 13
BIBM 5 Sample Time	J2 - 27	DO-2 14
BIBM 6 Sample Time	J2 - 29	DO-2 15
BIBM 7 Sample Time	J2 - 31	DO-2 16
BIBM 8 Sample Time	J2 - 33	DO-2 17
BCBM 1 Sample Time	J2 - 35	DO-2 18
BCBM 2 Sample Time	J2 - 37	DO-2 19
BCBM 3 Sample Time	J2 - 39	DO-2 20
BCBM 4 Sample Time	J2 - 41	DO-2 21
BCBM 5 Sample Time	J2 - 43	DO-2 22
BCBM 6 Sample Time	J2 - 45	DO-2 23
BCBM 7 Sample Time	J2 - 47	DO-2 24
BCBM 8 Sample Time	J2 - 49	DO-2 25
Harp 1 Command	J2 - 2	DO-2 26
Harp 2 Command	J2 - 4	DO-2 27

Note - unused pins on J2 and DO-2 will be ground

Timing card - Logic card interface

FUNCTION	Int Card	Timing Card	
Int Width	P2 - 1	J1 - 48	(A2)
/Int Width	P2 - 2	J1 - 47	
Advance	P2 - 3	J1 - 46	(A3)
/Advance	P2 - 4	J1 - 45	
Stop Scan(adv count output)	P2 - 5	J1 - 44	(A4) Counter number
/Stop Scan	P2 - 6	J1 - 23	
BCBM 1 Sample Time	P2 - 7	J1 - 42	(A5)
/BCBM 1 Sample Time	P2 - 8	J1 - 41	
BCBM 3 Sample Time	P2 - 9	J1 - 40	(B2)
/BCBM 3 Sample Time	P2 - 10	J1 - 39	
BCBM 4 Sample Time	P2 - 11	J1 - 38	(B3)
/BCBM 4 Sample Time	P2 - 12	J1 - 37	
BCBM 5 Sample Time	P2 - 13	J1 - 36	(B4)
/BCBM 5 Sample Time	P2 - 14	J1 - 35	
BCBM 6 Sample Time	P2 - 15	J1 - 34	(B5)
/BCBM 6 Sample Time	P2 - 16	J1 - 33	
INT DLAW	P2 - 17	J1 - 24	(A1)
/INT DLAW	P2 - 18	J1 - 23	
BCBM2	P2 - 19	J1 - 22	(B1)
/BCBM2	P2 - 20	J1 - 21	
GND	P2 - 21	J1 - 1	
GND	P2 - 22	J1 - 3	
Advance En	P2 - 23	J1 - 4	
GND	P2 - 24	J1 - 5	
Spare	P2 - 25	J1 - 8	
GND	P2 - 26	J1 - 9	
BCBM 8 Sample Time	P2 - 27	J2 - 48	(C2)
/BCBM 8 Sample Time	P2 - 28	J2 - 47	
BIBM 1 Sample Time	P2 - 29	J2 - 46	(C3)
/BIBM 1 Sample Time	P2 - 30	J2 - 45	
BIBM 2 Sample Time	P2 - 31	J2 - 44	(C4)
/BIBM 2 Sample Time	P2 - 32	J2 - 43	
BIBM 3 Sample Time	P2 - 33	J2 - 42	(C5)
/BIBM 3 Sample Time	P2 - 34	J2 - 41	
BIBM 5 Sample Time	P2 - 35	J2 - 40	(D2)
/BIBM 5 Sample Time	P2 - 36	J2 - 39	
BIBM 6 Sample Time	P2 - 37	J2 - 38	(D3)
/BIBM 6 Sample Time	P2 - 38	J2 - 37	
BIBM 7 Sample Time	P2 - 39	J2 - 36	(D4)
/BIBM 7 Sample Time	P2 - 40	J2 - 35	
BIBM 8 Sample time	P2 - 41	J2 - 34	(D5)
/BIBM 8 Sample time	P2 - 42	J2 - 33	
BCBM 7 Sample Time	P2 - 43	J2 - 24	(C1)
/BCBM 7 Sample Time	P2 - 44	J2 - 23	
BIBM 4 Sample Time	P2 - 45	J2 - 22	(D1)
BIBM 4 Sample Time	P2 - 46	J2 - 21	
GND	P2 - 47	J2 - 1	
GND	P2 - 48	J2 - 3	
RF CLK	P2 - 49	J2 - 4	
GND	P2 - 50	J2 - 5	
GND	P2 - 51	J2 - 7	

GND	P2 - 52	J2 - 9

Logic card P2 misc.

Function	From	To
A/D board trigger	P2 - 53	Analog card P2 - 21
Gnd	P2 - 54	
EOC Status	P2 - 55	Analog Card P2 - 23
Gnd	P2 - 56	
Gnd	P2 - 57	
Gnd	P2 - 58	
RF IN Hi	P2 - 59	BNC on rear panel
RF IN Low	P2 - 60	BNC on rear panel

~~Logic card J3~~

Scope trigger Start Scan	J3 - 13	Rear Panel BNC
Scope trigger Start Scan Lo	J3 - 14	Rear Panel BNC
Reset from 18603	J3 - 15	18603 J4 - 9
Reset to Cont. Sec. Rst Sw	J3 - 16	Cont sec. reset sw.
Comm Sec init	J3 - 17	Comm Sec. P1 - 14

Int. Reset Gauss	J3 - 5	Timing decoder J1-18	delayed from PKR
/Int. Reset Gauss	J3 - 6	Timing decoder J1-17	
Int. Reset Real-time delayed from PKR	J3 - 1	Timing decoder J2-18	
/Int. Reset Real-time	J3 - 2	Timing decoder J2-17	
Harp int. Start Gauss	J3 - 7	Timing decoder J1-20	delayed from PKR
/Harp int. Start Gauss	J3 - 8	Timing decoder J1-19	
Harp Int. Start Real-time delayed from PKR	J3 - 3	Timing decoder J2-20	
/Harp Int. Start Real-time	J3 - 4	Timing decoder J2-19	
Prepulse delayed	J3 - 9	Timing decoder J1-22	
/Prepulse delayed	J3 - 10	Timing decoder J1-21	

Timing board inputs

Signal	From	Timing Bd
1 MHZ CLK	Timing decoder J3 - 2	P2 - 2
GND	Timing decoder J3 - 1	P2 - 4
1 KHZ CLK	Timing decoder J3 - 8	P2 - 6
GND	Timing decoder J3 - 7	P2 - 8

MISC.

Signal	From	To	
	Comm section multibus	Control sect. Multibus	
EOG	P1 - 39	P1 - 39	MB INT 5
BTinj	P1 - 36	P1 - 36	MB INT 7

Data Rdy	P1 - 42	P1 - 42	MB INT 1

EVENT LINE INPUTS

Sign	From	Timing Decoder
Gauss Event line +	Rear Panel Gauss Twinex	P2 - 49
Gauss Event line -	Rear Panel Gauss Twinex	P2 - 47
Real-time line +	Rear Panel Real-time Twinex	P2 - 56
Real-time line -	Rear Panel Real-time Twinex	P2 - 55

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Analog signals

Analog input connector (AI1) is a 50 pin male 3M Delta ribbon connector # 3564 - 1000

Channel	FUNCTION	RTI - 711	Analog in 1
Ch 0 Hi	Scanner 1 - Harp 1 Hi	J2 - 4	AI1 - 2
Ch 0 Lo	Scanner 1 - Harp 1 Lo	J2 - 6	AI1 - 3
Ch 1 Hi	Scanner 2 - Harp 2 Hi	J2 - 8	AI1 - 4
Ch 1 Lo	Scanner 2 - Harp 2 Lo	J2 - 10	AI1 - 5
Ch 2 Hi	Scanner 3 - xfmr,bpm Hi	J2 - 12	AI1 - 6
Ch 2 Lo	Scanner 3 - xfmr,bpm Lo	J2 - 14	AI1 - 7
Ch 3 Hi	Spare Hi	J2 - 16	AI1 - 8
Ch 3 Lo	Spare Lo	J2 - 18	AI1 - 9
Ch 4 Hi	Spare Hi	J2 - 20	AI1 - 10
Ch 4 Lo	Spare Lo	J2 - 22	AI1 - 11
Ch 5 Hi	Spare Hi	J2 - 24	AI1 - 12
Ch 5 Lo	Spare Lo	J2 - 26	AI1 - 13
Ch 6 Hi	Spare Hi	J2 - 28	AI1 - 14
Ch 6 Lo	Spare Lo	J2 - 30	AI1 - 15
Ch 7 Hi	Spare Hi	J2 - 32	AI1 - 16
Ch 7 Lo	Spare Lo	J2 - 34	AI1 - 17

4.2 Operational Verification Procedures

4.2.1 ~~Faraday cup Actuators and~~ harp Actuators

4.2.1.1 With actual instruments commanding an instrument to insert should result in the instrument report indicating " In" on spread sheet. Commanding an instrument to retract should result in the instrument report indicating "Out" on spread sheet.

4.2.1.2 With digital cables disconnected . Use a meter or scope to look at the output line associated with the actuator being tested. (see I/O doc. above).

4.2.3 The various gains are checked by issuing the appropriate command and seeing that the correct levels are present on the line associated with that function and that the correct status is indicated on the instrumentation electronics. (see I/O doc. above).

4.2.4 The sample time is checked by triggering the scope on Peaker and looking at the sample outputs. Sample should occur at the time set on ~~spread sheet. (see I/O doc above).~~

4.2.5 The A/D is checked by applying the input voltage source to the analog input and asking for a data report from a device using configure. The report as seen in configure should report the hex equivalent of the voltage applied.

4.2.6 The Calibration of the A/D card is checked by varying the voltage calibrator and asking for reports from a particular device as the voltage is increased or decreased for each step. See the calibration sheet below.

Calibration of LTB Instrumentation Controller

Analog Devices RTI - 711 A/D Card

Meter - Beckman Tech 310 s.n. 212144446
Calibrator - Datel DVC 8500A s.n. 09670279

Lsb for A/D is 4.9 mv

Input V +	Reading Hex	Input V -	Reading Hex
0	1	0	1
.5 v	67	- .5 v	FF9A
1.0 v	CE	- 1 v	FF34
1.5 v	134	- 1.5 v	FECE
2.0 v	19A	- 2.0 v	FE67
2.5 v	201	- 2.5 v	FE01
3.0 v	267	- 3.0 v	FD9A
3.5 v	2CE	- 3.5 v	FD34
4.0 v	334	- 4.0 v	FCCE
4.5 v	39A	- 4.5 v	FC67
5.0 v	401	- 5.0 v	FC01
5.5 v	467	- 5.5 v	FB9A
6.0 v	4CE	- 6.0 v	FB34
6.5 v	534	- 6.5 v	FACD

7.0 v	59A	- 7.0 v	FA67
7.5 v	601	- 7.5 v	FA01
8.0 v	667	- 8.0 v	F99A
8.5 v	6CE	- 8.5 v	F934
9.0 v	734	- 9.0 v	F8CD
9.5 v	79A	- 9.5 v	F867
10.0 v	7FF	-10.0 v	F800

5.0 Maintenance

5.1 Planned Maintenance Schedule

Once a year during the Summer Shutdowm the fans inside the LTB instrumentation controller should be checked for proper operation.

At the same time the controller should be checked for dust accumulation.

5.2 Planned Maintenance procedures

To check proper operation of the fans turn the controller off and back on. The fans should start up immediately . If not or if the fan seems abnormally noisy , the fan should be replaced.

If the dust accumulation inside the chassis is excessive then the boards should be removed and cleaned and the inside of the chassis should be vacuumed. The multibus connectors on the backplane should be carefully checked for foreign matter between or on the connector pins.

5.3 Trouble Analysis Chart

NOTE: Any of the following problems could possibly be rectified by resetting the controller.
All of the problems described below could be the result of a bad power supply. Power supply voltages can be checked on front panel.

Symptom	Possible fault
No SLD Reports	1. Station or combox down 2. Station not loaded with controller/ Devices 3. Controller not turned on 4. IEEE - 488 cable to station disconnected 5. CM4 board faulty 6. Bad connection between CM4 and IEEE - 488 connector
Instruments cannot be inserted	1. Digital I/O ribbon cable disconnected 2. Interface card faulty 3. Parallel I/O 519 card faulty 4. Bad connection between cards inside controller
No data, no sample pulses	1. Digital I/O ribbon cable disconnected 2. Time lines disconnected 3. Bad timing decoder card 4. A/D card faulty 5. Interface card faulty 6. Timing card faulty 7. Bad connection between cards in controller

6.0 Special Replacement Parts

Part	Supplier	In use	Spares
SBC 88/25 CPU	Intel	1	1
SBC 186/03 CPU	Intel	1	1
MM7200D Memory	Micro Memory	1	1
SBC 519 Digital I/O	Intel	2	1
RTI 711 Analog Input	Analog Devices	1	1

NOTE: Spare parts may be shared by other controllers. For example there may be an 88/25 board that is a spare for this controller and the BTA Instrument controller.