THE ISAAC NEWTON GROUP OF TELESCOPES

ISAAC NEWTON TELESCOPE

TELESCOPE CONTROL SYSTEM

CAMAC

SYSTEM DESCRIPTION
MODULE BIT ALLOCATION TABLES
AND TROUBLESHOOTING GUIDE

REV 1.2

Author : E. J. Mills (Electronics Group)
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DOCUMENT HISTORY

Rev 1.0 First released May 31st 1999 E. J. MILLS
Rev 1.1 May 26th 2000 E. J. MILLS
- (a) Error found in crate 3 drawing. Modules 15 and 16 were interchanged.
- (b) Added notes on HYTEC 640VSL MultiDAC module

Rev 1.2 Nov 7th 2001 E. J. MILLS
- (a) Added another 3340 module to B4 C3 N19 for Sony transducer (fine focus position encoding)

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For her notes on the DEC ALPHA version of CAMAC TEST which I have included in this document

I. Overview

CAMAC (**C**omputer **A**utomated **M**easurement **A**nd **C**ontrol) is a control/data acquisition system based on CRATES and MODULES which was originally developed in the 1960's for the nuclear research industry (CERNE). It conforms to a standard both in mechanical and electronic specifications.

CAMAC is used to interface the various mechanisms of the telescope to and from the **TCS** (**T**elescope **C**ontrol **S**ystem). This being a **DEC ALPHA** computer running VMS. The term TCS as used in this document refers to both the telescope control software and the computer that it runs on. It performs various tasks such as reading the telescope's position encoders, providing the velocity demand for the servo motors, moving the dome, adjusting the focus, *etc.*

The crate's CAMAC BUS consists of 24 read/write lines which are used to pass data between the TCS and the outside world. The bus also carries lines for module number decoding, module sub-addressing, function codes, control signals, power rails and interrupt handling. In CAMAC terminology, these interrupts are known as LAM's (Look At Me). The bus is extended out to the other crates in the system using a high density twisted pair DATAWAY cable.

The INT CAMAC equipment comprises of three crates. A SYSTEM and two BRANCH crates located in the Clip Centre. Due to maximum cable length restrictions between the DEC ALPHA computer and the CAMAC dataway controller in the system crate, these are mounted in close proximity. The two branch crates are located in Bay 7.

The branch address is **B4**. This being determined by the location within the system crate of the double width **BRANCH COUPLER** module. In this case fitted in Slots 15/16. The crate addresses on the branch are determined by a small rotary switch on the branch **CRATE CONTROLLER** module. These being **C2** and **C3** respectively. As crate 3 is the last in the chain, the CAMAC dataway is terminated using a **BRANCH TERMINATOR** module.

According to CAMAC convention, the TCS addresses the crates using the following protocol:

B	Branch number	1 to 7	System crate is always B0 C0
C	Crate number	1 to 7	Determined by switch on Crate Controller
N	Module number	1 to 23	Slots 24/25 reserved for Crate Controller
A	Module sub-address	0 to 15	I/O, A or B channels *etc.*
F	Function	0 to 31	Read, write, test or set LAM *etc.*

The diagram on page 29 shows the general layout of the INT CAMAC SYSTEM. As the Time Service is an integral part of the TCS, the connections from it to CAMAC are shown also.

It should be noted that the Time Service not only provides accurate time (UTC) to the TCS via CAMAC, but also generates clock frequencies and pulses relative to UTC. These are used to synchronise the telescope's position encoders. See the ING Time Service manual for more information.

II. CRATE ASSIGNMENTS AND FUNCTIONS

System Crate B0 C0

- Provides the interface between CAMAC and the DEC ALPHA computer via the **HYTEC 1386** PCI controlled ACB CAMAC dataway controller.
- Reads UTC (year, day number of year, hours, minutes and seconds) from the Time Service. This data is in BCD format and read into the TCS using a **PR2402** parallel input register.
- Generates milliseconds referenced to UTC using the **LP34** module.
- Contains the **ED12** module which provides a 20Hz strobe pulse for staticising the encoders and generates the interrupt (LAM) signal for the TCS. The TCS is updated at 50mS (20Hz) intervals.
- Contains the **BR CPR 4-1** BRANCH COUPLER to allow access to the remote crates.

Branch Crate B4 C2

- Reads the Quick Motion (QM) **Ferranti** (H.A.) and **Heidenhain** (DEC) incremental tape encoders.

  RGO32BIT Counters are used. Three counter modules are used for H.A. The counts being averaged by the TCS. The more accurate Heidenhain tape encoder on the DEC axis uses two counter modules. These counts also being averaged by the TCS .

- Reads the temperature of the telescope tube structure to allow for focus tracking via an **ADC 1232** module.

Branch Crate B4 C3

- Produces the servo demand voltage from the TCS using a HYTEC **640VSL** (or **9085)** MultiDAC module.

Using **RGO32BIT** Counters

- Reads the Slow Motion (SM) H.A. and DEC **Baldwin** incremental encoders.

Using **PR2402/3** Parallel data input register modules.

- Reads the telescope Alarm and Limit status.
- Reads the Dome and Shutter status indicators (via TEM-L).
- Reads the Top and Bottom dome shutter position (* not implemented).
- Reads the Power Panel and Manual Override push buttons.
- Reads the telescope Cassegrain focus Turntable and Dome position.

Using **OD2407** Output Driver modules.

- Controls dome movement and direction. Sets the dome speed.
- Controls the movement and direction of the turntable and telescope focus.
- Engages or disengages the Slow Motion clamps depending on the drive rate.
- Allows Engineering mode to be selected by the TCS if desired when in Computer mode.

Using **3340** Serial data (RS232) modules.

- Communicates with the Prime focus cone unit (PFCU) MMS controller (WFC turntable).
- Reads the telescope focus (absolute) position from the ASL2300 LVDT signal processor.
- Reads the telescope fine (incremental) focus position from the Sony transducer.

III. SYSTEM CRATE

Module address: B 0 C 0 N 8

Type: **ED12** Clock Pulse Generator

Function: Provides 8 pulsed outputs software selectable using the 1MHz signal from the Time Service.

Output rate set to 20Hz. One output is used for clocking the encoder modules. Another is used as a strobe for the **LP34** Millisecond Generator. This module also provides the LAM to the DEC ALPHA computer via the interconnecting cable.

Camtest: *e.g.* EXEC 0 0 8 0 0 To read the data register.

CAMAC COMMANDS	FUNCTION	RESPONSE
A0 F0	Read data register	Q = 1
A0 F16	Overwrite data register	Q = 1
A15 F8	Test LAM	Q =1 if LAM set
A1 F9	Clear rate multiplier and filter	
A15 F10	Clear LAM	
A15 F24	Disable LAM	
A15 F26	Enable LAM	
A15 F27	Test LAM enabled	Q = 1 if enabled
A1 F24	Disable rate multiplier	
A1 F26	Enable rate multiplier	
A1 F27	Test rate multiplier enabled	Q =1 if enabled
Z	Initialise	
X	returned for all valid commands	X =1 if valid

CONNECTOR	SIGNAL
LEMO coax SK1 Input	1MHz clock from Time Service
LEMO coax SK2 Output	20Hz to LP37 fan-out module input
LEMO coax SK3 Output	20Hz to LP34 Millisecond Generator Strobe input

SYSTEM CRATE

Module address: B 0 C 0 N 10

Type: **PR2402** Parallel Input Register

Function: Reads UTC data in BCD format from the Time Service.

Camtest:

EXEC 0 0 10 0 0	To read register A	The current time in hrs:mins:secs
EXEC 0 0 10 1 0	To read register B	The current day number and year

REGISTER A	BIT	FUNCTION (bcd coded)	
A0	1	1	secs x 1
A0	2	2	secs x 1
A0	3	4	secs x 1
A0	4	8	secs x 1
A0	5	1	secs x 10
A0	6	2	secs x 10
A0	7	4	secs x 10
A0	8	-	
A0	9	1	mins x 1
A0	10	2	mins x 1
A0	11	4	mins x 1
A0	12	8	mins x 1
A0	13	1	mins x 10
A0	14	2	mins x 10
A0	15	4	mins x 10
A0	16	-	
A0	17	1	hours x 1
A0	18	2	hours x 1
A0	19	4	hours x 1
A0	20	8	hours x 1
A0	21	1	hours x 10
A0	22	2	hours x 10
A0	23/24	Not used	

REGISTER B	BIT	FUNCTION (bcd coded)	
A1	1	1	days x 1
A1	2	2	days x 1
A1	3	4	days x 1
A1	4	8	days x 1
A1	5	1	days x 10
A1	6	2	days x 10
A1	7	4	days x 10
A1	8	8	days x 10
A1	9	1	days x 100
A1	10	2	days x 100
A1	11	4	days x 100
A1	12	8	days x 100
A1	13	1	years x 1
A1	14	2	years x 1
A1	15	4	years x 1
A1	16	8	years x 1
A1	17	1	years x 10
A1	18	2	years x 10
A1	19	4	years x 10
A1	20	8	years x 10
A1	21/24	Not used	

SYSTEM CRATE

Module address: B 0 C 0 N 11

Type: **LP34** Millisecond Generator

Function: Generates milliseconds using the 1MHz and 1ppS signals from the Time Service.

Camtest : EXEC 0 0 11 0 0 To read register A
EXEC 0 0 11 1 0 To read register B

REGISTER A	BIT	FUNCTION
A0	1	2^0 mSecs Current time
A0	2	2^1 mSecs "
A0	3	2^2 mSecs "
A0	4	2^3 mSecs "
A0	5	2^4 mSecs "
A0	6	2^5 mSecs "
A0	7	2^6 mSecs "
A0	8	2^7 mSecs "
A0	9	2^8 mSecs "
A0	10	2^9 mSecs "

REGISTER B	BIT	FUNCTION
A1	1	2^0 mSecs Strobed time
A1	2	2^1 mSecs "
A1	3	2^2 mSecs "
A1	4	2^3 mSecs "
A1	5	2^4 mSecs "
A1	6	2^5 mSecs "
A1	7	2^6 mSecs "
A1	8	2^7 mSecs "
A1	9	2^8 mSecs "
A1	10	2^9 mSecs "

SOCKET	FUNCTION	FROM
Input LEMO 1	1MHz clock	From Time Service
Input LEMO 2	1 pulse per second	From Time Service
Input LEMO 3	Strobe input	From ED12

IV. BRANCH 4 CRATE 2

Module address: B 4 C 2 N 2 / 5 / 8

Type: **RGO 32 BIT COUNTER**

Function: Reads the quadrature signals from the HOUR ANGLE (HA) Quick Motion axis **Ferranti** grating tape encoder reading heads via the **Ferranti** encoder processing crate in Bay 6 and converts the data to an up/down binary value.

Camtest: *eg.* EXEC 4 2 5 0 0 To read the 16 LSB's of Register 1 (HA 2)

The CAMAC schedule below shows the most useful diagnostic commands.
Refer to the RGO 32 BIT counter manual (or HYTEC 900) for the full command set.

CAMAC COMMANDS	FUNCTION	RESPONSE
A0 F0	Read 16 LSB's of Register 1	Q = 1 X = 1
A1 F0	Read 16 MSB's of Register 1	Q = 1 X = 1
A2 F0	Read 16 LSB's of Register 2	Q = 1 X = 1
A3 F0	Read 16 MSB's of Register 2	Q = 1 X = 1
A12 F2	Read and clear the LAM status register	Q = 1 X = 1
A15 F8	Test LAM	Q = 1 if enabled X = 1
A0 F9	Clear the counter	Q = 1 X = 1
A0 F10	Clear all LAM's	Q = 0 X = 1
A0 F27	Test the Zero Marker counter clear facility	Q = 1 if enabled X = 1
A2 F27	Test the encoder zero reference strobe enable flag	Q = 1 if set X = 1

Notes:

- Register 1 (Status Bit 1) Data strobed by - 20Hz clock from the **ED12** module via the **LP37** module.
- Register 2 (Status Bit 2) Data strobed by - ZENITH pulse

- Status Bit 3 - Not used
- Status Bit 4 - Data strobed by - 30^o pulses
- Status Bit 5/8 - Not used

Station N2 Ferranti grating encoder head - HA 1 (6 o'clock position)
Station N5 Ferranti grating encoder head - HA 2 (10 o'clock position)
Station N8 Ferranti grating encoder head - HA 3 (2 o'clock position)

BRANCH 4 CRATE 2

Module address: B 4 C 2 N 11 / 14

Type: **RGO 32 BIT COUNTER**

Function: Reads the quadrature signals from the DECLINATION Quick Motion axis **Heidenhain** incremental tape encoder reading heads and converts the data to an up/down binary value.

Camtest: *e.g.* EXEC 4 2 14 3 0 To read the 16 MSB's of Register 2 (DEC 2)

The CAMAC schedule below shows the most useful diagnostic commands.
Refer to the RGO 32 BIT counter manual for the full command set.

CAMAC COMMANDS	FUNCTION	RESPONSE
A0 F0	Read 16 LSB's of Register 1	Q = 1 X = 1
A1 F0	Read 16 MSB's of Register 1	Q = 1 X = 1
A2 F0	Read 16 LSB's of Register 2	Q = 1 X = 1
A3 F0	Read 16 MSB's of Register 2	Q = 1 X = 1
A12 F2	Read and clear the LAM status register	Q = 1 X = 1
A15 F8	Test LAM	Q = 1 if enabled X = 1
A0 F9	Clear the counter	Q = 1 X = 1
A0 F10	Clear all LAM's	Q = 0 X = 1
A0 F27	Test the Zero Marker counter clear facility	Q = 1 if enabled X = 1
A2 F27	Test the encoder zero reference strobe enable flag	Q = 1 if set X = 1

Notes:

- Register 1 (Status Bit 1) Data strobed by - 20Hz clock from the **ED12** module via the **LP37** module.
- Register 2 (Status Bit 2) Data strobed by - ZENITH pulse

- Status Bit 3 - Not used
- Status Bit 4 - Data strobed by - unknown
- Status Bit 5/8 - Not used

Station N11 Heidenhain encoder head - DEC 1 (1 o'clock position)
Station N14 Heidenhain encoder head - DEC 2 (7 o'clock position)

BRANCH 4 CRATE 2

Module address: B 4 C 2 N 20

Type: **ADC 1232** 32 Channel Analogue to Digital Converter module (12 bit sampling)

Function: Reads the voltages corresponding to values of temperatures from the PT100 platinum sensors mounted on the telescope tube structure and mirror. The tube temperature sensor is used to monitor expansion or contraction of the truss and provides data for focus tracking corrections.

Camtest: *e.g.* EXEC 4 2 20 4 0 To read the raw value returned from the tube sensor.

The CAMAC schedule below shows the most useful diagnostic commands. Refer to the 1232 Users Manual for more information.

CAMAC COMMANDS	FUNCTION	RESPONSE
A0 F0	Read Top Ring temperature	Q = 1 X = 1
A1 F0	Read cube temperature	Q = 1 X = 1
A2 F0	Read mirror air temperature	Q = 1 X = 1
A3 F0	Read mirror temperature	Q = 1 X = 1
A4 F0	Read Serrurier Truss temperature	Q = 1 X = 1

V. BRANCH 4 CRATE 3

Module address: B 4 C 3 N 1

Type: LP37 RGO built Fan-out module

Function: Provides 9 buffered outputs to supply each **RGO32BIT Counter** with a 20Hz strobe input signal derived from the **ED12** module in the system crate.

Note: This module is NOT addressable by CAMAC. It simply uses the PSU rails in the crate to power the module. All outputs are electrically the same.

Co-axial link cables: See table below

LEMO CONNECTOR	FUNCTION
A	20Hz Input from ED12
B	
C	
1A	20Hz output to RGO32BIT counter Ferranti HA 1
2A	20Hz output to RGO32BIT counter Ferranti HA 2
3A	20Hz output to RGO32BIT counter Ferranti HA 3
1B	20Hz output to RGO32BIT counter Heidenhain DEC 1
2B	20Hz output to RGO32BIT counter Heidenhain DEC 2
3B	
1C	20Hz output to RGO32BIT counter Baldwin HA
2C	20Hz output to RGO32BIT counter Baldwin DEC
3C	

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 3 / 6

Type: **RGO 32 BIT COUNTER**

Function: Reads the quadrature signals from the HA (**N3**) and DEC (**N6**) Slow Motion axis **Baldwin** optical incremental encoders and converts the data to an up/down binary value.

Camtest: *e.g*. EXEC 4 3 3 0 0 To read the 16 LSB's of Register 1 (HA Baldwin)

The CAMAC schedule below shows the most useful diagnostic commands.
Refer to the RGO 32 BIT counter manual for the full command set.

CAMAC COMMANDS	FUNCTION	RESPONSE
A0 F0	Read 16 LSB's of Register 1	Q = 1 X = 1
A1 F0	Read 16 MSB's of Register 1	Q = 1 X = 1
A2 F0	Read 16 LSB's of Register 2	Q = 1 X = 1
A3 F0	Read 16 MSB's of Register 2	Q = 1 X = 1
A12 F2	Read and clear the LAM status register	Q = 1 X = 1
A15 F8	Test LAM	Q = 1 if enabled X = 1
A0 F9	Clear the counter	Q = 1 X = 1
A0 F10	Clear all LAM's	Q = 0 X = 1
A0 F27	Test the Zero Marker counter clear facility	Q = 1 if enabled X = 1
A2 F27	Test the encoder zero reference strobe enable flag	Q = 1 if set X = 1

Notes:

- Register 1 (Status Bit 1) Data strobed by - 20Hz clock from the **ED12** module via the **LP37** module.
- Register 2 (Status Bit 2) Data strobed by - ZENITH pulse

- Status Bit 3 Data strobed by - Encoder 1 rev per turn pulse
- Status Bit 4 Data strobed by - 30^{o} pulses
- Status Bit 5 Not used
- Status Bit 6 Not used
- Status Bit 7 Not used
- Status Bit 8 Not used

- **DEC BALDWIN (N6) no longer read by TCS since Heidenhain tape encoder was installed**

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 8

Type: **OD2407** Output Driver

Function: Channel A Dome and shutter control (via TEM-L)
Channel B Dome speed (via TEM-L)

Camtest: *e.g.* EXEC 4 3 8 0 16 002 To move the dome CCW.
EXEC 4 3 8 0 16 000 To stop the dome.
EXEC 4 3 8 1 16 256 Set full dome speed.

Note: Raising or lowering the dome shutters via computer control has never been implemented.

REGISTER A	**BIT**	**FUNCTION** Dome and shutter control
A0	1	Dome Drive - CW
A0	2	Dome drive - CCW
A0	3	Top Shutter - Main Raise
A0	4	Top Shutter - Main Lower
A0	5	Top Shutter - Micro Raise
A0	6	Top Shutter - Micro Lower
A0	7	Bottom shutter - Main Raise
A0	8	Bottom shutter - Main Lower
A0	9	Bottom shutter - Micro Raise
A0	10	Bottom shutter - Micro Lower
A0	11/24	Not used

REGISTER B	**BIT**	**FUNCTION** Dome speed
A1	1	1 1st decade
A1	2	2 “
A1	3	4 “
A1	4	8 “
A1	5	1 2nd decade
A1	6	2 “
A1	7	4 “
A1	8	8 “
A1	9/24	Not used

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 9

Type: **PR2402** Parallel Input Register

Function: Reads Top and Bottom dome shutter 10 bit absolute encoders

Camtest: *e.g.* EXEC 4 3 9 1 0 To read the bottom shutter encoder bits

Note: Although provision is made in CAMAC for reading the Top and Bottom dome shutter positions, in practice this has never been implemented.

REGISTER A	**BIT**	**FUNCTION** Top shutter encoder bits
A0	1	LSB 2^0 21.09' (Encoder shaft)
A0	2	2^1
A0	3	2^2
A0	4	2^3
A0	5	2^4
A0	6	2^5
A0	7	2^6
A0	8	2^7
A0	9	2^8
A0	10	MSB 2^9
A0	11/24	Not used

REGISTER B	**BIT**	**FUNCTION** Bottom shutter encoder bits
A1	1	LSB 2^0 21.09' (Encoder shaft)
A1	2	2^1
A1	3	2^2
A1	4	2^3
A1	5	2^4
A1	6	2^5
A1	7	2^6
A1	8	2^7
A1	9	2^8
A1	10	MSB 2^9
A1	11/24	Not used

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 10

Type: **PR2403** Parallel Input Register (opto-isolated inputs)

Function: Channel A Reads BINARY data from the 10 bit dome absolute encoder.
Channel B Reads BCD data from the 18 bit BCD Cass turntable encoder.

Camtest: *e.g.* EXEC 4 3 10 0 0 To read the dome encoder
e.g. EXEC 4 3 10 1 0 To read the Cass TT encoder

REGISTER A	**BIT**	**FUNCTION** DOME 10 BIT ABS ENCODER
A0	1	LSB 2^0 21.09^0 Encoder shaft
A0	2	2^1
A0	3	2^2
A0	4	2^3
A0	5	2^4
A0	6	2^5
A0	7	2^6
A0	8	2^7
A0	9	2^8
A0	10	MSB 2^9
A0	11/24	Not used

REGISTER B	**BIT**	**FUNCTION** CASS TT 18 BIT BCD ENCODER
A1	1	1 Degs x 10^{-2}
A1	2	2 "
A1	3	4 "
A1	4	8 "
A1	5	1 Degs x 10^{-1}
A1	6	2 "
A1	7	4 "
A1	8	8 "
AI	9	1 Degs
AI	10	2 "
AI	11	4 "
AI	12	8 "
AI	13	1 Degs x 10
AI	14	2 "
AI	15	4 "
AI	16	8 "
AI	17	1 Degs x 10^2
AI	18	2 "
A1	19/24	Not used

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 11

Type: **OD2407** Output Driver

Function: Channel A Move the Cass rotator and set the direction and speed.
Channel B Move the Focus position and set the direction and speed.

Camtest: *e.g.* EXEC 4 3 11 0 16 006 Move the Cass rotator in + direction at SLOW speed.
e.g. EXEC 4 3 10 1 16 002 Move the focus in - direction at FAST speed.

REGISTER A	**BIT**	**FUNCTION** MOVE CASS ROTATOR
A0	1	Move Cass rotator - direction
A0	2	Move Cass rotator + direction
A0	3	Select FAST motion
A0	4	Select SLOW motion
A0	5 - 24	Not used

REGISTER B	**BIT**	**FUNCTION** MOVE FOCUS POSITION
A1	1	Move focus in direction 1 = + 0 = -
A1	2	Power 1 = ON 0 = OFF
A1	3	Speed 1 = SLOW 0 = FAST
A1	4 - 24	Not used

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 12

Type: **PR2402** Parallel Input Register

Function: Channel A **Not Used** (was focus position)
Channel B Focal station indicator and mirror cover position

Camtest: *e.g.* EXEC 4 3 12 1 0 Read focus station in use and mirror cover status

REGISTER B	BIT	FUNCTION Focal station indicator and mirror cover status
A1	1	Focus Indication - Cass
A1	2	Focus Indication - Coude (not used)
A1	3	Focus Indication - Prime
A1	4	Focus - Upper Limit
A1	5	Focus - Lower Limit
A1	6	Main mirror - Closed = 1
A1	7	Main mirror - Open = 1
A1	8	Secondary mirror - Closed = 1 (not used)
AI	9	Secondary mirror - Open = 1 (not used)
AI	10-24	Not used

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 13

Type: **PR2402** Parallel Input Register

Function: Channel A Read alarm and limits status.
Channel B Read dome and shutter status indicators (via TEM-L).

Camtest: *e.g.* EXEC 4 3 13 0 0 Reads the telescope limits and alarm status.
e.g. EXEC 4 3 13 1 0 Reads the fan, dome and shutter status indicators.

REGISTER A	**BIT**	**FUNCTION** Alarms and limits
A0	1	H.A (-) pre-limit
A0	2	H.A. (-) final limit
A0	3	H.A. (+) pre-limit
A0	4	H.A. (+) final limit
A0	5	DEC (-) pre-limit
A0	6	DEC (-) final limit
A0	7	DEC (+) pre-limit
A0	8	DEC (+) final limit
A0	9	Horizon limit
A0	10	Power amplifier overload
A0	11	DEC tie bar
A0	12	Oil pressure
A0	13	Air (mirror support)
A0	14	Mains (telescope supply)
A0	16	Spare
A0	17	Spare
A0	18	Wind (not connected)
A0	19	Rain
A0	20	Ice (not connected
A0	21/24	Not used

REGISTER B	**BIT**	**FUNCTION** Fan, Dome and Shutter status (via TEM-L)
A1	1	Vent Fan Group 1 Indicator
A1	2	Vent Fan Group 2 Indicator
A1	3	Vent Fan Group 3 Indicator
A1	4	Vent Fan Group 3 Indicator
A1	5	Dome REMOTE Indicator
A1	6	Dome POWER ON Indicator
A1	7	Top Shutter REMOTE Indicator
A1	8	Top Shutter POWER ON Indicator
A1	9	Top Shutter SPARE
A1	10	Top Shutter OVER TRAVEL Alarm
A1	11	Bottom Shutter REMOTE Indicator
A1	12	Bottom Shutter POWER ON Indicator
A1	13	Bottom Shutter SPARE
A1	14	Bottom Shutter OVER TRAVEL Alarm
A1	15/24	Not used

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 14

Type: **9085** MultiDAC (12 bit sampling) See compatibility note* below

Function: Generates a voltage relative to the demanded drive rate derived from the TCS.

Camtest: *e.g.* EXEC 4 3 14 0 16 1990 Move the telescope in H.A. at approx. SIDEREAL RATE.

Notes: This 12 bit DAC module generates an output voltage between +/- 5V. Writing a value of 2048 to any of the channels will set the output of that channel to 0V. *i.e.* The telescope will be stationary.

A value of approx. 1990 sent to Channel 1 will move the telescope at SIDEREAL RATE from east to west.

* **Compatibility:**

The 9085 module is no longer made. However a direct replacement is the **HYTEC 640VSL**. This module is now in use in the INT. It has only 4 outputs compared to the 9085 module which had 12, but this is of no consequence as only the top 4 outputs are used.

It should be noted that the HYTEC 640VSL has an additional function (a RUN led) and that the module needs to be ENABLED before it can be read. This is done by sending an F26 command.

The TCS software has been updated to add this ENABLE command on start-up, but the software will still work with the older 9085 modules.

Refer to the HYTEC 640VSL manual for the full instruction set.

ADDRESS	CHANNEL NUMBER	FUNCTION
A0	1	H.A. SLOW MOTION drive rate
A1	2	H.A. QUICK MOTION drive rate
A2	3	DEC SLOW MOTION drive rate
A3	4	DEC QUICK MOTION drive rate
A4 - A11	Not used	Not used (9085 DAC only)

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 15

Type: **OD2407** Output Driver

Function: Channel A HA and DEC Slow Motion Clamp control.
Channel B Resets TCS to Engineering mode.

Camtest: *e.g.* EXEC 4 3 15 0 16 016 Select MANUAL controls.
e.g. EXEC 4 3 15 1 16 001 Reinstate Eng. Mode if Computer mode is selected.

Notes: When the Slow Motion clamps are released, Quick Motion (QM) is selected by the TCS. There is NO computer control over the QM clamps which are permanently engaged for normal telescope operations.

Bit 1 on register B is a one shot signal. If it remains high, it will NOT be possible to re-select COMPUTER mode using the keyswitch.

REGISTER A	**BIT**	**FUNCTION** Release and engage Slow Motion clamps
A0	1	H.A. SM Clamps Engaged
A0	2	H.A. SM Clamps Disengaged
A0	3	DEC SM Clamps Engaged
A0	4	DEC SM Clamps Disengaged
A0	5	Select Manual control (all functions)
A0	6 / 24	Not used

REGISTER B	**BIT**	**FUNCTION** Engineering mode toggle
A1	1	Reset engineering mode Bit 1 = 1
A1	1	Re-enable Computer mode (via key-switch) Bit 1 = 0
A1	2/24	Not used

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 16

Type: **PR2402** Parallel Input Register

Function: Channel A Read Power Supply panel push button status.
Channel B Read Manual Override push button status.

Camtest: *e.g.* EXEC 4 3 16 0 0 Read Power Supply panel push buttons.
e.g. EXEC 4 3 16 1 0 Read Manual Override push buttons.

REGISTER A	**BIT**	**FUNCTION** Power supply panel push button status
A0	1	Emergency Stop
A0	2	Reset button
A0	3	Telescope Power (on = 1)
A0	4	Eng. or Computer mode (comp = 1)
A0	5 - 24	Not used

REGISTER B	**BIT**	**FUNCTION** Manual Override push button status
A1	1	Not used
A1	2	Not used
A1	3	Focus
A1	4	Dome and Shutters
A1	5	R.A.
A1	6	DEC
A1	7	Cass Turntable
A1	8/24	Not used

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 17

Type: **3340** Serial Communications CAMAC Interface

Function: Provides communications over an RS232 link for the Prime Focus Cone Unit MMS controller. (*nb.* Only used now for the WFC turntable)

Camtest: *e.g.* EXEC 4 3 17 0 0 Reads the input register.

Notes: An abbreviated list of commands are shown below. Refer to the 3340 Users Manual for more information.

CAMAC COMMANDS	FUNCTION	RESPONSE
F0 A0	Reads the Input register and clears LAMS 2 / 7	Q = 1 X = 1 Q = 0 for buffer empty
F1 A0	Reads the status register	Q = 1 X = 1
F1 A12	Reads the LAM status register	Q = 1 X = 1
F1 A14	Reads the LAM request register	Q = 1 X = 1
F8 A15	Tests if a LAM request is present	Q = 1 X = 1
F9 A0	Clears the buffer memories and UART	Q = 1 X = 1
F16 A0	Writes the Output register and clears LAM 1	Q = 1 X = 1 Q = 0 for buffer full
F17 A0	Writes the Mode register	Q = 1 X = 1
F17 A13	Writes the LAM mask register	Q = 1 X = 1
F23 A12	Selectively clears the LAM status register	Q = 1 X = 1
Z	Clears LAM status register, LAM mask register, Buffer Memories, Mode register and UART	

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 18

Type: **3340** Serial Communications CAMAC Interface

Function: Provides communications (read only) over an RS232/RS422 link for the **ASL2300** focus (absolute) transducer processor. *i.e.* The Focus position in millimetres.

nb. To provide a high noise immunity due to the long distance involved, RS422 line drivers are mounted at each of the link.

Camtest: *e.g.* EXEC 4 3 18 0 0 Reads the input register.

Notes: An abbreviated list of commands is shown below. Refer to the 3340 Users Manual for more information.

CAMAC COMMANDS	FUNCTION	RESPONSE
F0 A0	Reads the Input register and clears LAMS 2 / 7	Q = 1 X = 1 Q = 0 for buffer empty
F1 A0	Reads the status register	Q = 1 X = 1
F1 A12	Reads the LAM status register	Q = 1 X = 1
F1 A14	Reads the LAM request register	Q = 1 X = 1
F8 A15	Tests if a LAM request is present	Q = 1 X = 1
F9 A0	Clears the buffer memories and UART	Q = 1 X = 1
F16 A0	Writes the Output register and clears LAM 1	Q = 1 X = 1 Q = 0 for buffer full
F17 A0	Writes the Mode register	Q = 1 X = 1
F17 A13	Writes the LAM mask register	Q = 1 X = 1
F23 A12	Selectively clears the LAM status register	Q = 1 X = 1
Z	Clears LAM status register, LAM mask register, Buffer Memories, Mode register and UART	

BRANCH 4 CRATE 3

Module address: B 4 C 3 N 19

Type: **3340** Serial Communications CAMAC Interface

Function: Provides communications (read only) over an RS232/RS422 link for the **Sony** focus (incremental) transducer processor. *i.e.* The Focus position in microns.

nb. To provide a high noise immunity due to the long distance involved, RS422 line drivers are mounted at each of the link.

Camtest: *e.g.* EXEC 4 3 19 0 0 Reads the input register.

Notes: An abbreviated list of commands is shown below. Refer to the 3340 Users Manual for more information.

CAMAC COMMANDS	FUNCTION	RESPONSE
F0 A0	Reads the Input register and clears LAMS 2 / 7	Q = 1 X = 1 Q = 0 for buffer empty
F1 A0	Reads the status register	Q = 1 X = 1
F1 A12	Reads the LAM status register	Q = 1 X = 1
F1 A14	Reads the LAM request register	Q = 1 X = 1
F8 A15	Tests if a LAM request is present	Q = 1 X = 1
F9 A0	Clears the buffer memories and UART	Q = 1 X = 1
F16 A0	Writes the Output register and clears LAM 1	Q = 1 X = 1 Q = 0 for buffer full
F17 A0	Writes the Mode register	Q = 1 X = 1
F17 A13	Writes the LAM mask register	Q = 1 X = 1
F23 A12	Selectively clears the LAM status register	Q = 1 X = 1
Z	Clears LAM status register, LAM mask register, Buffer Memories, Mode register and UART	

IV. APPENDIX

I. CAMAC TEST ON THE DEC ALPHAS

To run CAMTEST, first open up a new LAT session window on the TCS X-terminal. Open a connection to the DEC ALPHA (INT name… LPAS2)

Username: ENGINEER
Password: ************ (in printed manual)

When logged in:

Option> camtest

The software will load and after a short time the prompt below will be displayed.

CAMTEST>

The following is a very basic guide to the use of CAMTEST. For more help, type HELP inside CAMTEST. Commands are NOT case sensitive and can be abbreviated where appropriate.

To send a single CAMAC instruction:

CAMTEST> execute B C N A F DATA

Where B C N A F are the Branch, Crate, module station Number, sub-Address and Function numbers respectively. DATA is only needed for a write instruction (F16). Insert one space between each number.

The result will be displayed on the screen showing the B C N A F data, read and write data and the Q response.

To see the results of all previous instructions, type:

SHOW EXEC.

This list can be deleted by: DELETE EXEC

A CAMAC instruction can be repeated with a specified period, enter:

EXECUTE/REPEAT=*n*/PERIOD=*m* B C N A F DATA

Where *n* is the number of times to repeat the instruction and *m* is the period between the instructions expressed in milliseconds. The default is 1 Second if *m* is not given.

To break out of a repeat sequence, use `Control C'.

Examples:

EXEC 4 2 11 1 0	Will do a single read of a module in Branch 4, Crate 2, slot Number 11 and sub-Address 1 (*e.g.* Channel B)
EXEC /REPEAT=100/PERIOD 4 2 11 1 0	Will perform 100 reads at intervals of 1 sec. The results can be viewed by SHOW EXEC
EXEC 4 1 2 0 16 124	Will write the data 124 to the specified CAMAC register

You can create a sequence of instructions for execution later using the ADD command. The format is:

ADD B C N A F DATA Where data is only required for a write instruction.

The sequence can be listed by:

SHOW INSTRUCTIONS and executed by EXECUTE.

The list can be deleted by:

DELETE INSTRUCTIONS.

The last line can be deleted by:

DELETE/LAST INSTRUCTIONS.

The **output** of an instruction can be displayed in binary, octal, decimal, or hexadecimal. Use the command RADIX to change it. Examples below show how the results are displayed in the CAMTEST window.

```
CAMTEST> radix binary
CAMTEST> exec 4 3 8 0 16 1184800   (e.g.  Write an alternate 24 bit pattern)

B  C  N  A  F     Write data                       Read data                     Q
4  3  8  0  0     101010101010101010101010         000000000000000000000000      1

CAMTEST> radix hexadecimal
CAMTEST> exec 0 0 10 0 0        (e.g. Read the Time Service:  hrs:mins:secs)

B  C  N  A  F     Write data                       Read data                     Q
0  0  10 0  0     00000000                         00143418                      1
```

You can create a text file containing CAMTEST commands. The INPUT command is used to read a file and execute the instructions.

INPUT READ_MECS.DAT

Will execute each line in the file READ_MECS.DAT sequentially. When the end of the file is reached, CAMTEST will resume taking input from the terminal.

To exit from CAMTEST :

CAMTEST> exit

Type: EXIT again at the Options prompt to close down the session.

II. TROUBLESHOOTING CAMAC

Most problems with CAMAC can be diagnosed using the CAMTEST program which is available on all the DEC ALPHA computers. See the previous section on how to use CAMTEST.

Whenever changing modules in a crate, always **SHUTDOWN** the DEC ALPHA telescope control system (TCS) before **SWITCHING OFF** the CAMAC crate. Switching off a crate or taking it **OFF LINE** whilst the TCS is running can cause the control software to crash. From the User prompt enter:

USER> tcsexit   and wait for the TCS to run down.

CAMTEST can also be run simultaneously with the TCS *e.g*. Monitoring the raw data from an encoder module whilst the telescope is tracking, dome moving *etc*. However, when examining individual bits, it is better to start up CAMTEST **WITHOUT** the TCS running. The reason being is that the TCS is constantly updating CAMAC and can overwrite the bits that are under test.

The notes below have been written to provide the technician with some idea of how to use CAMTEST to isolate problems. This is by no means a definitive treatise on solving every problem with CAMAC that may arise. In practice, especially during an emergency callout, try to isolate the CAMAC module associated with the problem and change the module with a spare. Detailed investigations can be carried out in `slow time` during the day.

DIAGNOSTIC TOOLS FOR CAMAC AND GENERAL CRATE FAILURES

All CAMAC crates contain a DTM4 or similar dataway test monitor. Although this module can be read from or written to using CAMTEST instructions, it will show **ALL** activity on the bus irrespective of whether it is being directly addressed. There are 24 LED’s for the READ Lines, 24 LED’s for the WRITE lines and other LED’s for ADDRESS and FUNCTION codes , control lines and LAM.

When CAMAC is under the control of the TCS, some of the dataway monitor LED’s will be flickering (at 20Hz).This is a good sign that the TCS is at least communicating with CAMAC. If activity is seen on the SYSTEM crate, but **NOT** on a BRANCH crate then possibly the problem is just that a branch crate has been knocked OFF-LINE.

Check that the ON-LINE switches both on the BRANCH COUPLER (in the system crate) and the CRATE CONTROLLER (located in slots 24/25 in the branch crates) are in the ON position. If this is not the problem then suspect either a faulty Branch Coupler or Crate Controller. Spares are available.

If there is NO activity on the SYSTEM crate then suspect the HYTEC 1386 PCI Dataway Controller, the PCI interface board within the DEC ALPHA or the cable connecting the computer to the Dataway Controller.

Another good test to see if the TCS is communicating with the system crate is to read the Time Service. All three telescope CAMAC systems use the same module configurations in the system crate. The Time Service BCD data (hrs:mins:secs) are read into CAMAC using a PR2402 Parallel Input Register in slot 10.

The “A” channel of the PR2402 (sub-address = 0) receives this data.

Start CAMTEST and enter at the prompt:

CAMTEST> exec 0 0 10 0 0

The result displayed should be the current UTC value. Check it against the control room time displays. Repeating the command (or making CAMTEST perform multiple reads) will show the seconds updating.

TESTING THE CAMAC SYTEM MANUALLY

If a problem is suspected with the computer to CAMAC link, it is possible to test CAMAC as a standalone system using the **SC-TST-1** Test Controller. This at least will prove that the system crate is working correctly, is addressing it's own modules or can address modules in branch crates.

To do this, proceed as follows:

- After bringing down the TCS (using TCSEXIT) , run down the DEC ALPHA using the SHUT account .
- When the DEC ALPHA has run down and returned the OK prompt, switch it off.
- Switch off the SYSTEM CRATE and remove the HYTEC 1386 (no need to remove the front panel cable).
- In it's place, fit an **MX-CTR-3** Executive Crate controller (slots 24/25).
- Fit the **SC-TST-1** Test Controller in a spare slot. *nb*. This module is triple width and will require 3 spare adjacent slots. *e.g.* 18, 19 and 20
- Fit an ARBITRATION BUS cable (with 4 pin LEMO's each end) between the Executive Controller and the 'IN' socket on the SC-TST-1 . These are kept in the INT electronics workshop in the draw near the CAMAC test rack .
- Power on the system crate and check for activity. Toggling the C/Z switch on the MX-CTR-3 is advisable.

The SC-TST-1 contains two rows of switches (Operation 1 and 2) allowing module address, sub address and functions to be set up or modules in branch crates to be checked. The test module can work in 3 modes:

1. Continuous (Clocking at 1MHz)
2. Slow speed (at 10Hz)
3. Single step

A typical test procedure would be to use the SC-TST-1 in conjunction with a Word Generator module such as the WGR 241. Put this module into any spare slot and set up the SC-TST-1 (N switches) to address that slot and perform an F0 (read) command using the left hand column of switches (operation 1). Set up the right hand column of switches (operation 2) to the module number of the DTM4 and select the F16 (write) function.

Put the SC-TST-1 into either continuous or 10Hz mode and toggle the switches on the Word Generator. If all is working correctly, you will see the switch patterns selected appearing on the READ leds on the DTM4 and the same pattern being written to the WRITE leds. *e.g.*

- Write all ones   111111111111111111111111
- Write all zeros   000000000000000000000000
- Alternate bits   101010101010101010101010
- Reverse bits   010101010101010101010101

These manual tests will prove that the problem lies with the HYTEC 1386 , the cable or PCI DEC ALPHA interface card.

Refer to the drawing on page 34 which shows the MANUAL TEST SETUP.

BUS HANGUPS

These fortunately are rare, but a faulty module can hold bits on the bus which will generally show up as bad data being returned from ALL the modules within a crate and the telescope doing "strange" things. This is particularly so if the faulty or stuck bit/s are of a lower order. The reason being that the telescope's mechanisms driven or read by CAMAC conventionally use BIT 1 and upwards.

If the dataway monitor shows bits set after the crate has been taken OFF LINE and the C/Z buttons toggled on the branch CRATE CONTROLLER or the C/Z switch toggled on the HYTEC 1386 DATAWAY CONTROLLER (if the problem is in the system crate) then a faulty module is probably causing the problem.

The solution here is to remove (slide back) all the modules within the crate just leaving the dataway monitor (DTM4 or equivalent) and CRATE CONTROLLER in place and see if the bits clear on the DTM4 after toggling the C/Z buttons or switch. If all the bits are clear then re-seat the modules one at a time until the stuck bit re-appears on the dataway monitor.

MISSING X or Q RESPONSE

All CAMAC modules generate an X and Q response. These are flags generated within the modules to tell the computer that a valid command has been received (X=1) or that a certain condition has been achieved (Q=1) or in some cases Q=0. The dataway monitor has LED's to show the status of these two flags.

However, on one occasion, the computer failed to see a change of the Q response although the module which was generating it (in this case a 3340 serial interface) was working correctly! The fault was eventually traced to the BRANCH COUPLER in the system crate. A faulty CRATE CONTROLLER or HYTEC 1386 module could also have been responsible.

Note
The bottom line here is with ANY bus related problems, change the HYTEC 1386 followed by the BRANCH COUPLER in the system crate then the branch CRATE CONTROLLERS. A faulty module (or cable) on the dataway can cause all sorts of problems and are the most difficult to solve. Simply changing these components is the best solution.

POWER SUPPLY UNIT FAILURES

CAMAC crate PSU's deliver +/- 6V between 20/40A and a +/- 24V low current supply. It should be noted that most modules contain a fuse and a voltage regulator to reduce the incoming +6V supply to the +5V required for the TTL logic. Some lightly populated modules don't use voltage regulators at all, but instead use a high current diode in series with the incoming +6V supply and rely on the 0.6V drop across the junction to derive a nominal +5V supply for the module.

PSU failures were once a common problem usually with the heavily loaded +6V supply failing due to overheating. This was caused primarily by the cooling fans wearing out and stopping. Power supply failures have now been greatly alleviated by replacing the heavy current linear supplies with a switched mode PSU. These have been fitted into existing CAMAC PSU boxes and can be identified by their light weight! The older units being extremely heavy and often difficult to manipulate into the guide rails in the back of the crate.

A small test box with a selector switch and 4 LED'S that plugs into the 9 pin `D` type connector on the front of the crate can be used to check the health of the PSU. Sockets on the box enable a test meter to be connected for a more accurate measurement. The PSU test box is kept in the INT electronics workshop in the draw near the CAMAC test rack. If a PSU is suspected as faulty, replace it with a spare. There should be one close by.

MODULE FAILURES

To cover every problem is impossible, but basically, module failures can be divided into two classes:

1. Those which affect the telescope directly (pointing, tracking, slewing *etc*)

2. Those which cause problems with the telescope sub-systems (focus, rotators, dome rotation *etc*)

Modules used for telescope control

Position encoders

Pointing and tracking problems can be caused by a faulty **RGO32BIT COUNTER** module. The INT uses 7 of these counters.

Three are used to read the HA axis **Ferranti** tape encoder heads when the telescope is in Quick Motion (slewing) and one is used to read the HA **Baldwin** incremental encoder after Slow Motion has been engaged (final positioning and tracking).

On the DEC axis, two counters are used to read the **Heidenhain** tape encoder heads.

nb. There is also a counter for reading the DEC Baldwin incremental encoder, but because of the high accuracy of the **Heidenhain** tape encoder, this has been considered unnecessary and has been disabled in software. There is a provision in the TCS software for enabling and disabling encoders.

If the telescope is having a problem with pointing or not going into 'Tracking', look in the TCS encoder info page. Command is :

USER> page enc

The three Ferranti encoder values should be in agreement or very close. The two Heidenhain encoder values also. If there is a big disparity between values, suspect a faulty RGO32BIT COUNTER module before investigating the encoder hardware. It should also be noted that the HA Baldwin encoder **MUST** be enabled and working correctly for the telescope to get into tracking. *n.b*. <u>The Baldwin encoders have been replaced with a version that uses LED's as a light source.</u>

If the tape encoder values look similar and the HA Baldwin encoder is working correctly, but there is still a problem with the telescope getting into tracking, the fault may lie with the MultiDAC Module.

As a preliminary check, look at the LED bar displays on the counter modules. When the telescope is slewing, all the counter modules in Branch Crate 2 will be counting either up or down depending on the direction that the telescope is moving.

When Slow Motion has been selected and the telescope is tracking, the LED bar displays on the modules associated with the DEC axis will be stationary, but the HA counters in Branch Crate 2 **AND** the HA Baldwin encoder counter in Branch Crate 3 will show counting at a slow rate.

This check will prove at least the RGO32BIT COUNTERS are receiving data from the encoders. However, seeing the LED bar display `counting` does not necessarily mean that the counter modules are working correctly.

Using the RGO32BIT module description within this document, use CAMTEST (and with the telescope moving VERY SLOWLY in Engineering Mode (get someone to push the HA or DEC + / – button), test for bits changing sequentially in the LSB's (A0 F0) and MSB's (A1 F0) of Register 1.

<u>If in any doubt, change what you suspect could be a faulty module with a spare.</u>

The MultiDAC module

This provides a DC voltage within the range +/- 5V depending on the servo velocity demand value calculated by the TCS. This voltage is sent to the HA (RA) and DEC servo pre-amplifiers. The output from these DC amplifiers now with velocity feedback added from the tacho is fed to the servo power amps which drive the motors.

The DAC samples to 12 bit resolution and is such that a value of 2048 equates to a value of 0V. *i.e.* When the telescope is stationary. If the telescope is creeping when at zenith park (in Computer control), it could be the case that the DAC requires re-calibration (refer to the manual on the 640/9085 on how to do this), but more likely, this is due to op-amp drift in the servo pre-amplifier boards and the associated offset null potentiometers will need adjusting.

If the telescope is oscillating or the POSITION ERROR as shown on the TCS Infodisplay is never reaching zero then suspect the MultiDAC.

n.b. <u>It should also be noted that a faulty RGO32BIT counter can also cause a similar problem.</u>

Modules used for the telescope sub-systems

Such problems could show up as the telescope focus, dome or rotator refusing to move (or not stopping) or returning the wrong position or status. The focus temperature tracking not working *etc.* The most common problems here are loosing a bit (or several bits) in a Parallel Input Register or Output Driver module.

For parallel 24 bit input or output modules, there are two TEST BOXES available to simulate reading or writing to these modules. If the module under test performs a more complex function then refer to the CAMTEST examples given for a particular module within this document.

To use the Test Box, remove either the A or B connector from the suspect module and in their place connect the appropriate test cable with the `Hughes plug` from the test box. The larger Hughes connector is for input registers, the smaller one for the output drivers. Don't forget to connect the test box + ve supply (a flying lead with a 9 pin D plug) to the PSU test connector on the front of the CAMAC crate.

n.b. Be sure to line up the Hughes plug before re-connecting. The pins are very fragile and it's very easy to misalign and damage them. They also have a habit of pushing back into the body of the connector if misaligned !

Refer to the specific module data pages within this document for the bit assignments.

Input Registers

Run up CAMTEST and set up an EXECUTE B C N A F instruction.

Where:
B = Branch number of the crate where the suspect module is located. (4 = All branch crates 0= System crate)
C = Crate number (2 or 3 =Branch crates 0= System crate)
N = Module slot number (1 to 23)
A = Module sub-address (0 or 1 for channel A or B respectively)
F = 0 Read instruction

For input register faults (e.g. PR2402/3 modules), use the 24 switches on the box to set or clear individual bits and examine the bit patterns returned in CAMTEST (or as displayed on the DTM4 24 **READ** LED's. The usual test is to SET all bits to 1 then CLEAR the bits by reversing the switches. Another useful test is to alternate the switches then reverse the order to check for adjacent bit problems.

Examples

Bit 24 SWITCHES Bit 1		
MSB LSB		
111111111111111111111111	Set bits high	FFFFFF hex
000000000000000000000000	Clear bits	
010101010101010101010101	Alternate bits	555555 hex
101010101010101010101010	Reverse bits	AAAAAA hex

n.b. If the module under test is a **PR2403**, this uses opto-isolated inputs. Switch the OPTO/STANDARD switch on the test box to the OPTO position to ensure that the correct input level is used.

Output Drivers

With these checks, use the 24 LED's on the test box as indicators. Remove the front panel A or B connector and plug the output driver cable from the test box to the OD2407 channel under test.

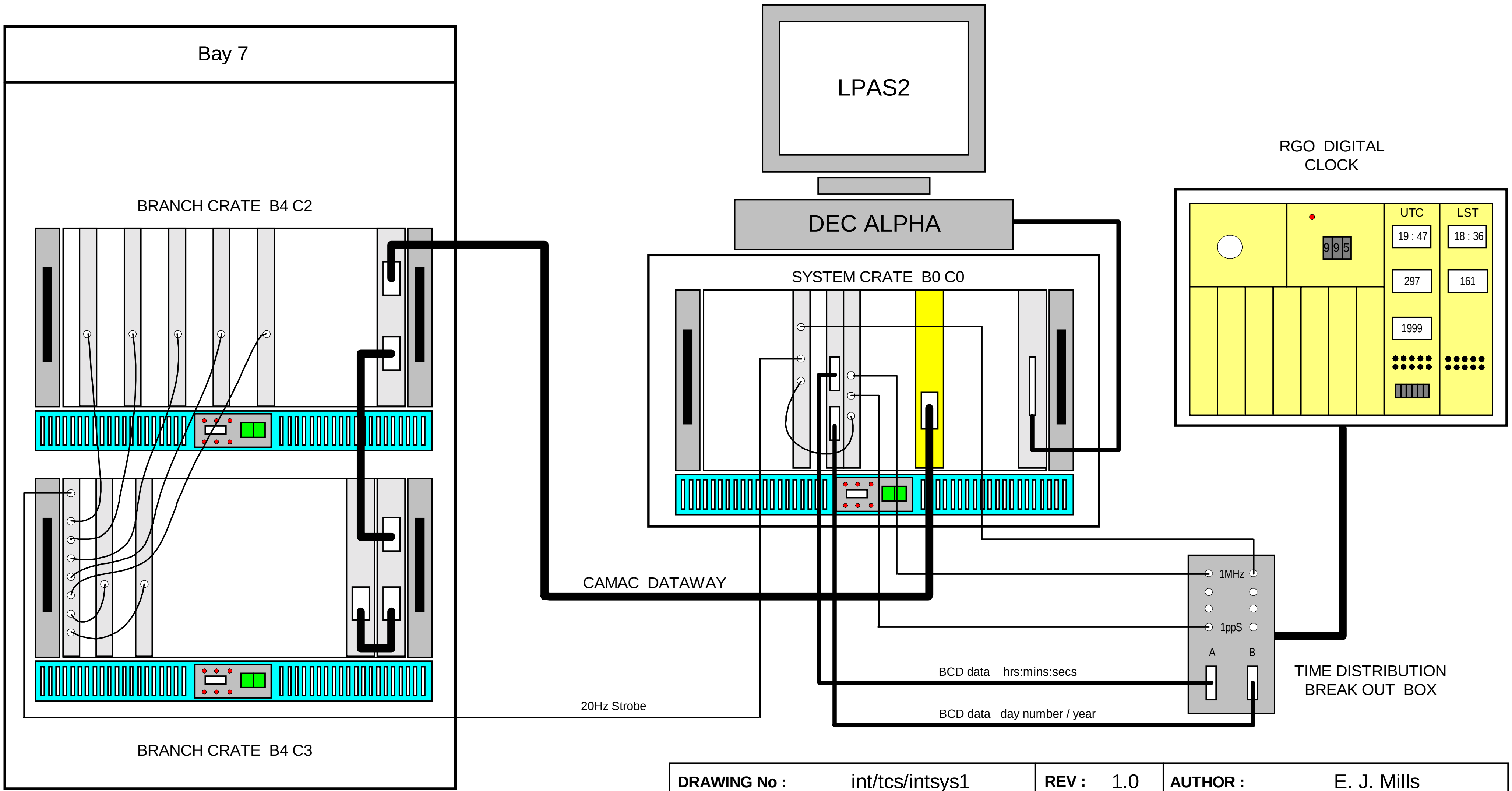
Set up CAMTEST to write to the selected channel. (F=16)

e.g. With the test box connected to the OD2407 in Branch 4, Crate 2 , slot Number 8 and Channel B

CAMTEST> exec 4 2 8 1 16 16777215	Set all bits high	FFFFFF hex
CAMTEST> exec 4 2 8 1 16 00000000	Clear all bits	
CAMTEST> exec 4 2 8 1 16 5592405	Produce alternate 24 bit pattern	555555 hex
CAMTEST> exec 4 2 8 1 16 11184810	Reverse alternate 24 bit order	AAAAAA hex

Monitor the bit patterns on the LED's for any abnormalities. The DTM4 (or similar) bus monitor will also reflect the same bit patterns on it's 24 **WRITE** LED's.

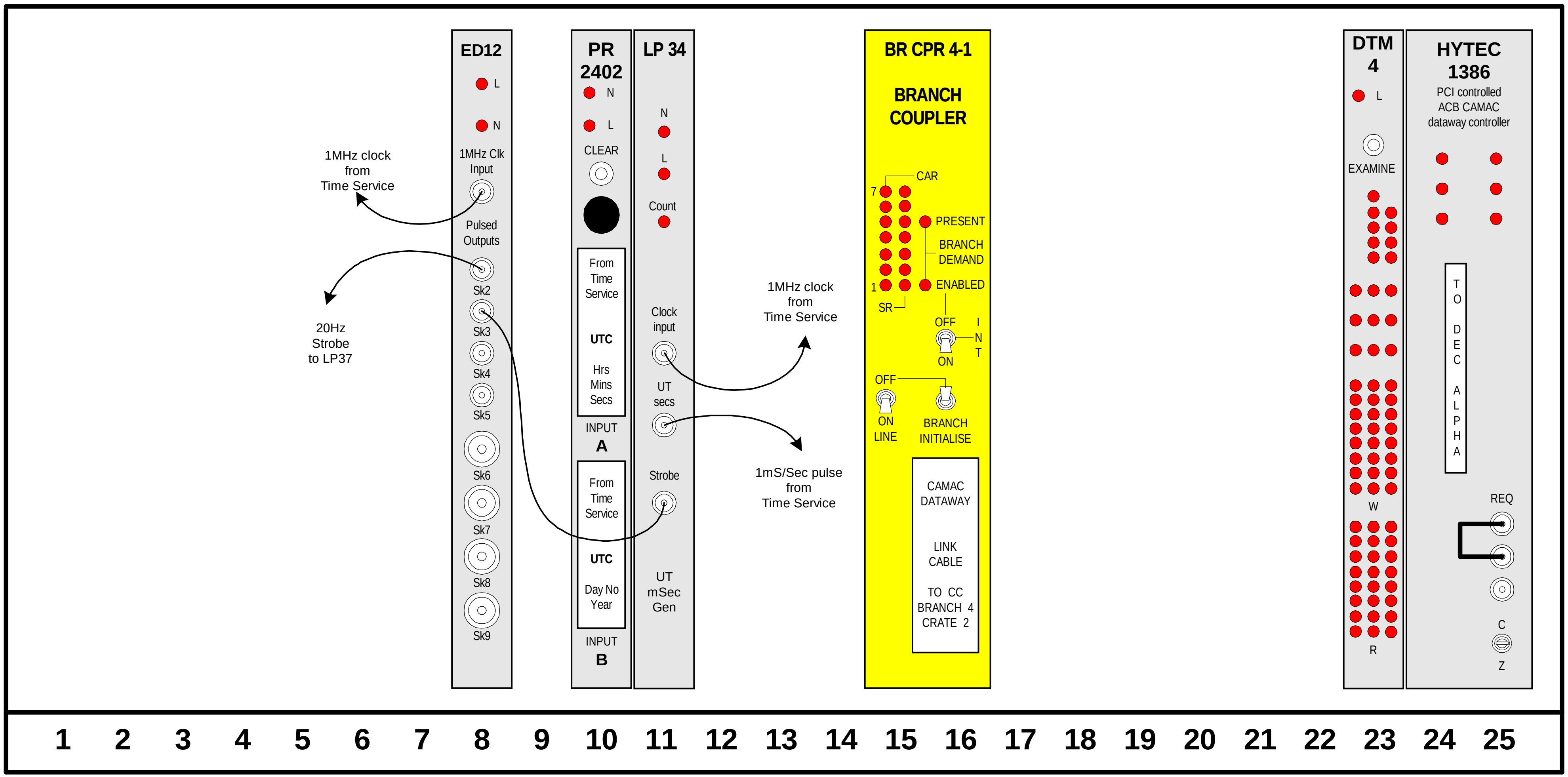
INT TCS CAMAC dataway, Time Service and encoder module strobe connections



DRAWING No :	int/tcs/intsys1	**REV :**	1.0	**AUTHOR :**	E. J. Mills
FILENAME :	~eng/electronics/int/intsys1.vsd	**SYSTEM :**	INT TCS	**DATE :**	05/11/98

Figure 1 INT CAMAC Crate layout, dataway and Time Service cables

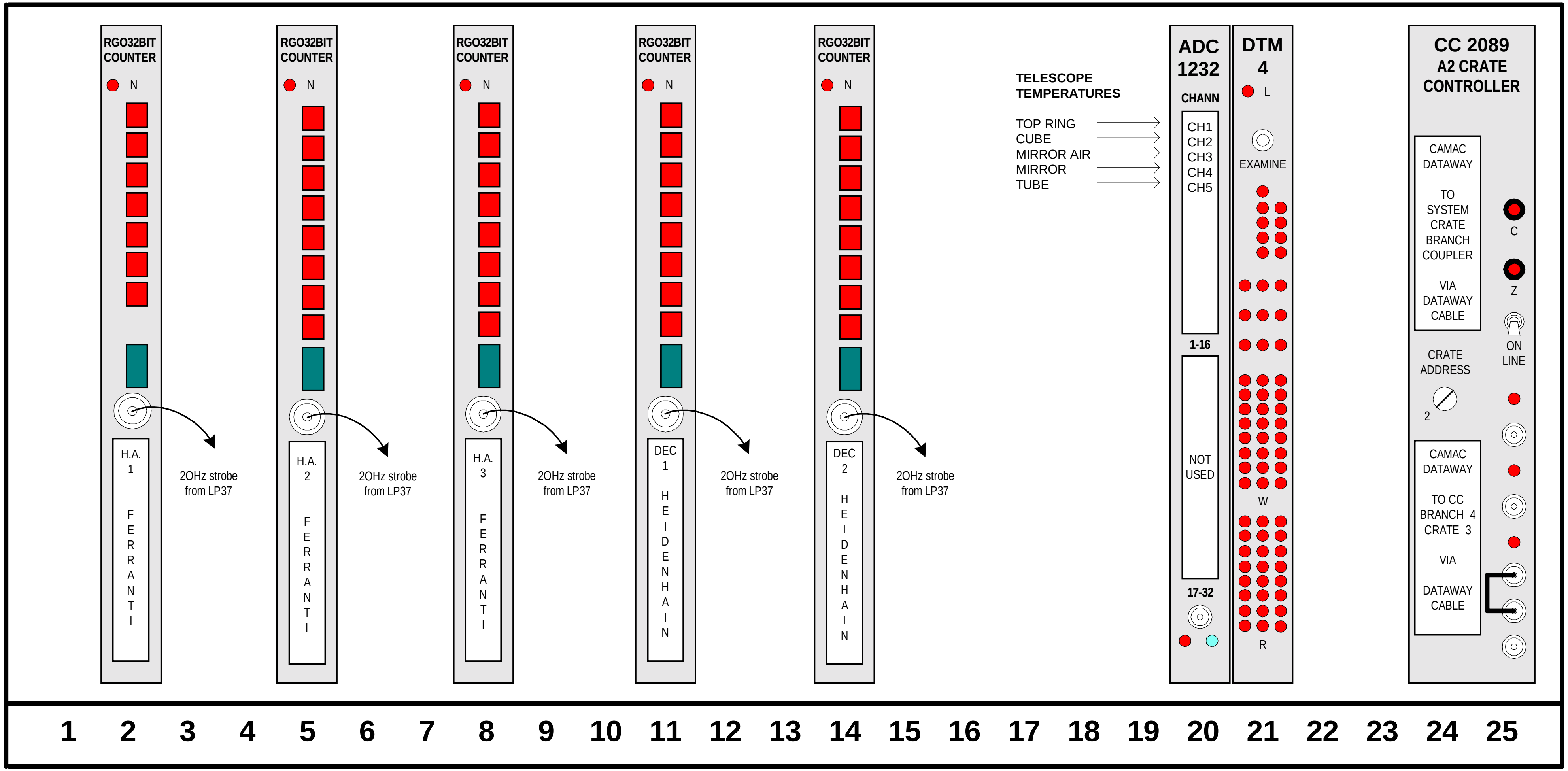
INT TCS CAMAC SYSTEM CRATE ADDR : B0 C0



DRAWING No : int/tcs/cam/crate1		**REV :** 1.1	**AUTHOR :** E. J. Mills		
FILENAME : ~eng/electronics/int/intcam1.vsd		**SYSTEM :** INT camac		**DATE :** 26/10/98	

Figure 2 INT CAMAC System crate

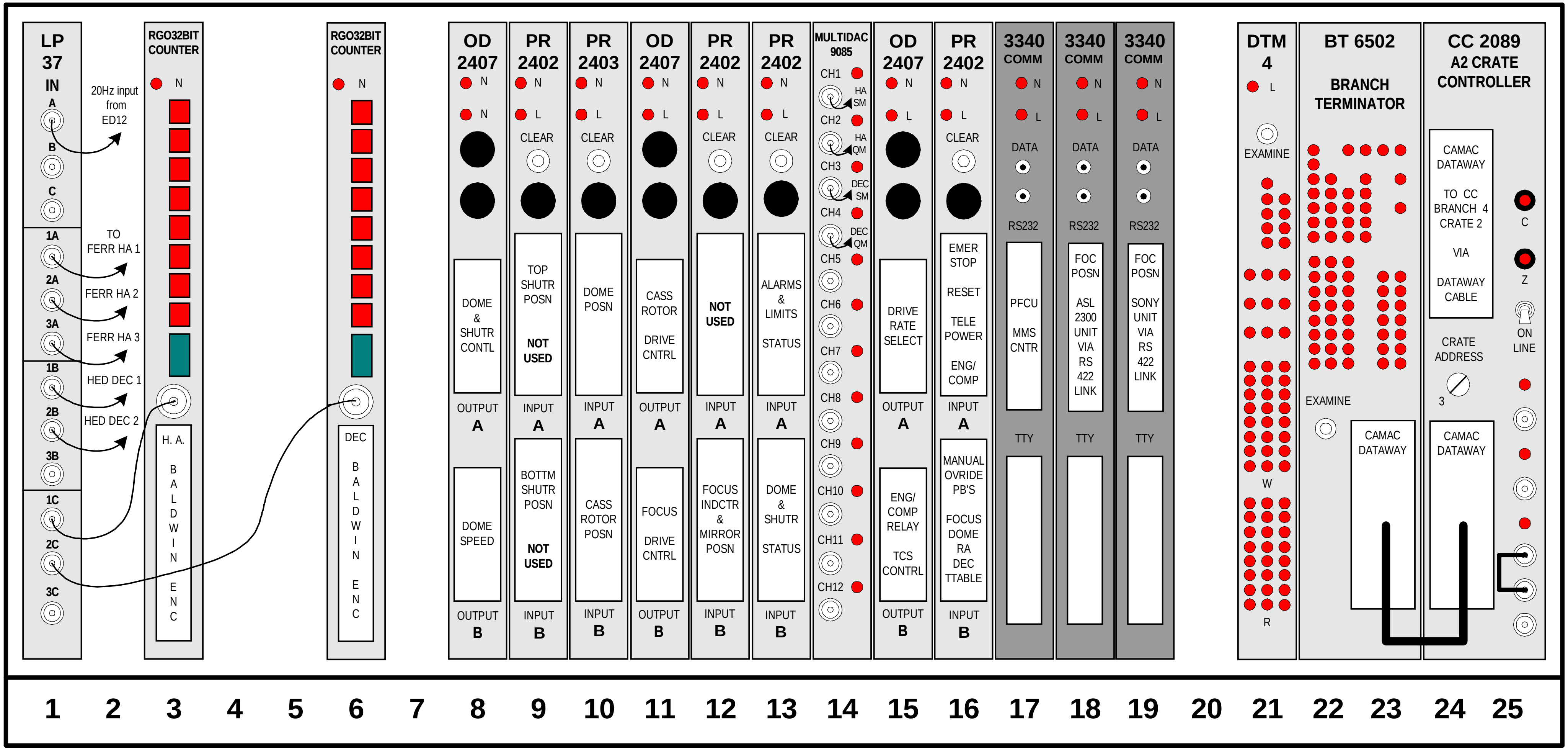
INT TCS CAMAC BRANCH CRATE ADDR : B4 C2



DRAWING No :	int/tcs/cam/crate2	**REV :**	1.1	**AUTHOR :**	E. J. Mills
FILENAME :	~eng/electronics/int/intcam2.vsd	**SYSTEM :**	INT camac	**DATE :**	26/10/98

Figure 3 INT CAMAC Branch crate 2

INT TCS CAMAC BRANCH CRATE ADDR : B4 C3

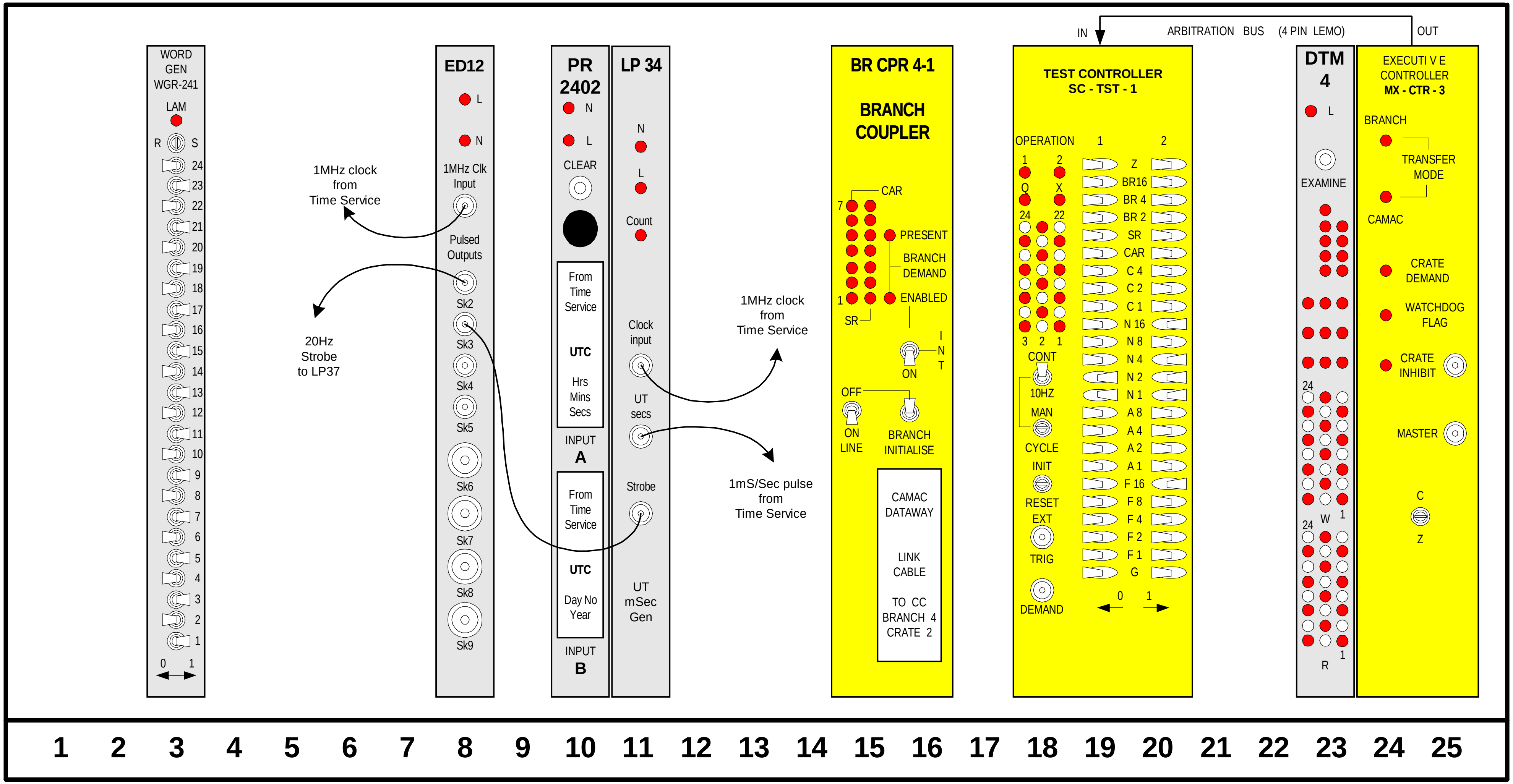


NOTE : Multidac module in N14 is interchangeable with newer versions e.g. HYTEC 640VSL

DRAWING No : int/tcs/cam/crate3	**REV :** 1.3	**AUTHOR :** E. J. Mills	
FILENAME : ~eng/electronics/int/intcam3.vsd	**SYSTEM :** INT camac	**DATE :** 7/11/01	

Figure 4 INT CAMAC Branch crate 3

INT TCS CAMAC MANUALLY TESTING THE SYSTEM CRATE



DRAWING No : int/tcs/cam/test-setup	REV : 1.1	AUTHOR : E. J. Mills	
FILENAME : ~eng/electronics/int/intcam4.vsd	SYSTEM : CAMAC		DATE : 07/6/99

Figure 5 INT CAMAC Test module setup in system crate