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CONTROL MODULE

OPERATING MANUAL

Warranty

Extent

Sifam Instruments Limited ("Sifam Instruments") warrants that the System shall for a period of twelve months from the date of delivery be free from defects in design, workmanship and materials (other than defects attributable to ordinary wear and tear) and, where applicable, shall meet the specifications referred to in the Special Conditions. If the System does not conform to such warranty Queensgate Instruments shall at its option:

(a) replace the System or any part of it found by Sifam Instruments in its sole judgment not to conform to the warranty (all parts replaced by Queensgate Instruments becoming the property of Queensgate Instruments); or

(b) take such steps as Sifam Instruments deems necessary to bring the System into a state where it is free from such defects or meets such specifications, PROVIDED THAT if there is a manufacturer's guarantee in force in respect of the System or any part thereof, the period of twelve months shall be substituted by the period left to expire of such manufacturer's guarantee.

Limitation

Subject as herein provided the aggregate liability of Sifam Instruments in contract, for negligence or otherwise shall in no event exceed the price payable or paid by the BUYER for the System and performance of either one of the options under the above warranty shall constitute an entire discharge of Sifam Instruments's liability under the above warranty.

Conditions

The above warranty is conditional upon:

(a) the BUYER providing Sifam Instruments with adequate written notice of the alleged defect within the above warranty period;

(b) the BUYER affording Sifam Instruments reasonable opportunity to inspect the System on site;

(c) the BUYER using and maintaining the System in accordance with any instructions or recommendations of Sifam Instrument and in particular not subjecting the System to misuse, abuse, neglect, accident, improper alteration or modification or negligence in use, storage, transportation or handling;

(d) as regards defects in design, the design in question not having been made, furnished or supplied by the BUYER

Control Module

Operating Manual

Torquay, Devon, United Kingdom
Fourth Edition, July 2000.
Document number DPT1100M4

Safety Precautions

WARNINGS

HAZARDOUS VOLTAGES

The Control Module relies on the provision of a protective earth (ground) conductor to prevent user accessible components developing a hazardous potential in the event of an insulation failure. A protective earth (ground) connection MUST be made to the unit.

DO NOT remove the equipment's cover. There is no user serviceable parts within the equipment and removal of the cover will invalidate the Sifam Instruments Warranty.

CAUTIONS

ELECTROSTATIC SENSITIVE DEVICES (ESD)

The unit contains components that are susceptible to damage through electrostatic discharge at the NanoMechanism and interface connectors.

Removal of the protective connector covers and connection of cables should be performed in a static safe environment using approved static safety handling procedures (e.g. procedures to BS5783).

Protective covers should be left in place on unused connectors.

ENVIRONMENT

The unit is designed for use in an office or laboratory environment.

Extremes of temperature, humidity, dust or acoustic/mechanical vibration may cause faulty operation or damage to components.

Electromagnetic Compatibility & Low Voltage Directive

CE

The Queensgate® NS2000 modules conforms to the CE Marking Directive 93/68/EEC.

Relevant standards:

1 EMC

Emissions

BS EN 50081-1 1992 EMC Emissions – Residential, commercial and light industrial (class B level).

Immunity

BS EN 50082-1 1992 EMC Immunity – Residential, commercial and light industrial (Class B level). The AX101/AX301 system relies for its operation on the detection of very small signals from its capacitance bridge. As such, exposure to interference fields as defined in BS EN 50082-1 1992 Immunity Standard, Residential, commercial and light industrial may cause spurious voltage fluctuations to the piezo translator causing undesired motion.

2 Safety

BS EN 61010-1, Safety requirements for electrical equipment for measurement control and laboratory use.

8 May 1997

Dr. Thomas Hicks
Chief Scientist
SDL Queensgate Ltd

Damage in Transit

The contents of the package should be thoroughly inspected immediately upon receipt.

All material in the container should be checked against the packing list. The manufacturer will not be responsible for shortages against this list unless notified immediately.

If the instrument is damaged in any way, a claim should be made against the carrier. A full report of the damage should be made, including the type and serial number of the instrument, and forwarded to Sifam Instruments Ltd.

Upon receipt of this report, you will be advised of the disposition of the instrument for repair or replacement.

Table of Contents

1 Introduction

Digital Piezo Translators (DPT-C) are piezo-electric translation devices capable of moving up to 70 µm with very high linearity and essentially perfect repeatability. Hysteresis is less than a nanometer. The DPT-C comes out of more than 100 man-years of R&D and attains 20 times higher accuracy than any other device on the market.

Ordinary piezo-electric translators are non-linear and exhibit hysteresis and creep. To overcome these problems a position sensor is built into each DPT-C. The output of this sensor controls the voltage on the piezo-electric stack so as to remove the hysteresis, non-linearity and creep.

Each DPT-C is supplied with a calibration curve, which can serve as a basis to correct the very small residual non-linearity.

The position sensing circuitry and piezo drive amplifiers have been miniaturised and packaged in a stand alone **Control Module** (CM), which requires only ± 15Vdc to operate. This makes the DPT-C particularly suitable for volume OEM applications. The CM comes complete with analogue input, 14-bit parallel digital interface, status lines and position monitor.

A Control Module is required to operate a DPT-C. The Control Module can be mounted in either the AX101 (single channel) or AX301 (three-channel) Host Unit, which provides ±15V for module(s), position display, optional IEEE-488 or RS232 interfaces, and allow manual control of the translators. A variety of accessories are available. Host units require mains supply. Alternatively the CM can be used stand alone, powered by ±15Vdc supply. The CM can interface to a computer, via a Digital I/O card mounted inside the computer (e.g. National Instruments PC-DIO-24 - 24 lines of digital I/O).

1.1 How does a Digital Piezo Work?

The key to the outstanding positioning accuracy and repeatability achieved by the DPT-C is Sifam Instruments's unique capacitance sensor technology. Each DPT-C contains a capacitance position sensor, which has picometer sensitivity. Changes in the length of the DPT-C are detected by this sensor and used to control its length.

DPT-Cs are made of Zerodur (a low thermal expansion coefficient glass) and Invar to minimise temporal and thermal drift. The DPT-C operates in a closed servo-loop incorporating an almost perfect integrator stage - as a result the DPT-C is extremely stiff. As loads on the device change its length so the servo loop responds, changing the voltage on the piezo stack to correct for these perturbations. The DPT-C has a slew rate of 1µm.ms^{-1}, and a noise level of less than 1nm rms (root mean square).

The capacitance sensors developed for the DPT-C are now also available as separate units, for other applications, which demand the highest possible position sensitivity. Please contact us for further information.

1.2 Unpacking & Handling the Control Module & DPT-C

1.2.1 Unpacking

The contents of a CM / DPT-C system are listed as follows:

Table 1: CM/DPT-C system contents

ITEM		QUANTITY
Control Module		1
DPT-C		1
CM Power cable		1
Results sheets (including non-linearity graphs).		1
Disk containing this manual (DPT1100M)		1
Screws (sample screws for mounting DPT-C).	M3 x 6mm	2
(part # MIS-0170-L)	M3 x 16mm	2

1.2.2 Handling

The CM and DPT-C are robust units and require no special handling precautions other than that normally followed with electronic equipment.

Static discharge to any of the connectors may cause damage, so **insure that all personnel handling the unit are adequately grounded.**

1.3 Product Range Summary

Table 2: Product Range Summary

ORDER CODE	DESCRIPTION
ELECTRONICS	
CM	Standard Control Module (CM)
CM-LD	Control Module with Low Drift option
CM-LN	Control Module with Low Noise option
CM-LD-LN	Control Module with Low Drift and Low Noise option
AX101	Single channel Host unit, including power supply, manual control and displays
AX301	3-channel Host unit, including power supply, manual control and displays
IEEE488-AX	IEEE-488 interface for AX101 or AX301 host units
RS232-AX	RS232 interface for AX101 or AX301 host units
TRANSLATORS	
DPT-C-L	70µm Translator
DPT-C-M	35µm Translator
DPT-C-S	15µm Translator
DPT-C-L-VAC	70µm Vacuum translator
DPT-C-M-VAC	35µm Vacuum translator

ORDER CODE	DESCRIPTION
DPT-C-S-VAC	15µm Vacuum translator
DPT-C-L-UVAC	70µm Ultra high vacuum translator
DPT-C-M-UVAC	35µm Ultra high vacuum translator
DPT-C-S-UVAC	15µm Ultra high vacuum translator
ACCESSORIES	
BEP5	Ball End Piece
FS12.5	Mirror 12.5mm
FS25	Mirror 25mm
MBA	Aluminium mounting block
MBI	Invar mounting block
MEP	Magnetic End Piece
PEP	Plane End Piece
VEP3	V groove end piece
EC3	3m Extension Cable
EC5	5m Extension Cable
EC8	8m Extension Cable
PC241CM	Cable to drive 1 CM using PC-DIO-24 Digital I/O computer card from National Instruments.

2 DPT-C Specifications and Installation

2.1 DPT-C Specifications

Table 3: DPT-C Specifications

PARAMETER		**DPT-C-S**	**DPT-C-M**	**DPT-C-L**
Range		>15µm	>35µm	>70µm
Length		42.2mm ±0.3mm	76.7mm ±0.3mm	127.8mm ±0.3mm
Diameter		20mm ±0.15mm		
Mass (without cable & connector)		70gms (typical)	110gms (typical)	170gms (typical)
Non linearity[1]		≤0.1%	≤0.15%	≤ 0.15%
Temperature Coefficient		15nm $°C^{-1}$ (typical)	25nm $°C^{-1}$ (typical)	35nm $°C^{-1}$ (typical)
Tilt		0.5arcsec μm^{-1} (typical)		
Repeatability		≤1nm		
Cable length[2]		2000mm to 2080mm		
Operating voltage		520Vdc max.		
Mounting method		M3 threaded end pieces		
Operating Pressure Range	- VAC	$10^{-3}\tau$ to $10^{-8}\tau$		
	- UVAC	$10^{-3}\tau$ to $10^{-8}\tau$		
Operating Temperature		+ 10°C to + 50°C		
Storage Temperature		0°C to + 70°C		
Relative Humidity		5% to 95 % (Non-condensing)		

Notes:

1 Guaranteed non-linearity when matched/calibrated with a CM.

2 3m, 5m and 8m extension cables (EC3, EC5 and EC8 respectively) are available to increase the overall length.

3 Specifications marked (typical) are for information and guidance and are not guaranteed in normal production. Contact Sifam Instruments for further information.

2.2 Handling the DPT-C

The DPT-C is a micro-positioning device of exceptional resolution and stability. It requires care in use and **MUST NOT** be subjected to large torques. Applying excess torque could damage the DPT-C.

The sleeve is designed to constrain the rotation of the top piece. Excessive force could break this sleeve bond.

Recommended tightening torque for both threaded end pieces is 0.35Nm.

Once the actuator is installed, ensure that the head is NOT touching the sleeve as this may introduce a small amount of hysteresis and some perpendicular movement. (HEAD of the actuator is defined as the top moving part of the actuator containing the M3 mounting point).

2.3 Installing the DPT-C

The actuator should be fixed at the base (cable end) to a ground flat surface.

The actuator should NOT be held by the sleeve, since this will result in hysteresis and thermal drift. Extension is measured at one end relative to the other and NOT relative to the sleeve.

Once the actuator is installed, ensure that the head is NOT touching the sleeve as this may introduce a small amount of hysteresis and some perpendicular movement. (HEAD of the actuator is defined as the top moving part of the actuator containing the M3 mounting point).

WARNING:
If both ends of the device are constrained, then damage may occur. In such a situation it is recommended that the actuator be spring loaded rather than over constrained.

2.4 Pre-Load

The DPT-C is internally pre-loaded to 100N and hence can exert a pulling force up to this value. The pushing force is typically 200N.

When an actuator is externally pre-loaded, the nominal position may have to be set, see section 3.9.1.

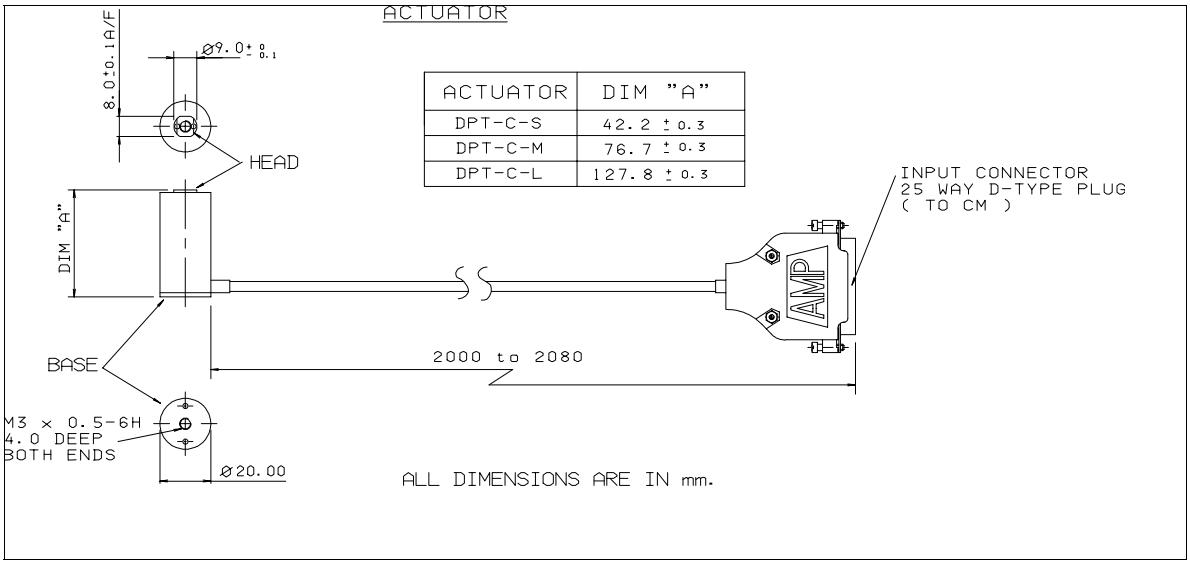
For higher loads, contact Sifam Instruments for advice.

2.5 Vacuum and Ultra High Vacuum Options

DPT-C's with vacuum options should NOT be powered up in soft vacuum. The vacuum MUST be better than 10^{-3} τ otherwise arcing inside the DPT-C could cause damage to the Control Module.

2.6 Translator Installation Drawing

Figure 4: DPT-C Installation Drawing



ACTUATOR	DIM "A"
DPT-C-S	42.2 ± 0.3
DPT-C-M	76.7 ± 0.3
DPT-C-L	127.8 ± 0.3

3 Operating Instructions for Control Module

There is HIGH VOLTAGE (550Vdc max) inside the CM and on the 25-way connector to the actuator. Do NOT power up CM when actuator is disconnected or when the CM lid is removed.

3.1 CM Specifications

Table 5: CM Specifications

PARAMETER		CM	CM-LN	CM-LD	CM-LN-LD
DC Power	Positive rail	+15V ±0.5V @ 220mA quiescent (500mA max)			
	Negative rail	-15V ±0.5V @ 220mA quiescent (500mA max)			
Temperature Coefficient		0 ±25nm $°C^{-1}$	0 ±25nm $°C^{-1}$	0 ±5nm $°C^{-1}$	0 ±5nm $°C^{-1}$
Noise		<1.0nm rms	<0.5nm rms	<1.0nm rms	<0.5nm rms
Bandwidth (factory set) [1]	DPT-C-S	300Hz ±20Hz			
	DPT-C-M	150Hz ±20Hz			
	DPT-C-L	70Hz ±10Hz			
Slew Rate		$1\mu m \cdot ms^{-1}$			
Analogue Command (for full actuator scan range)		-10V to +10V			
Digital Command (for full actuator scan range)		14-bit, TTL and CMOS (Parallel input)			
Power and Interface Connector		37-way D-type Plug (PCB mount)			
Actuator Interface[2]		25-way D-type socket (PCB mount)			
Size (L × W × H)		218mm × 77mm × 34mm			
Operating Temperature		+ 10°C to + 50°C			
Storage Temperature		0°C to + 70°C			
Relative Humidity		5% to 95 % (Non-condensing)			

Note:

1 The bandwidth can be adjusted by the customer if necessary. Contact Sifam Instruments for instructions.

2 This connector has high voltage (up to 550Vdc) when powered up.

Do NOT power up CM when actuator is disconnected.

It is recommended that linear power supplies be used to reduce noise introduced by the power supply.

Connecting power incorrectly may cause damage to the module.

The DPT-C position, from nominal, can be controlled via the differential analogue input or the digital input. Both are bipolar inputs and are capable of moving the actuator over it's entire range,

i.e. both inputs will contract **and** expand the DPT-C by half the full range from it's nominal (mid-range) position.

DPT-C scan position is derived from the sum of the analogue and digital inputs.

3.2 CM Interface

Pin designation on the 37-way D-type connector on the CM is shown in Table 6.

Table 6: CM Interface

Pin No.	Designation
1	+ 15V (power)
2	- 15V (power)
3	0V (power)
4	0V (power)
5	Bar graph Reference
6	Range o/p
7	0V (Analogue)
8	+ve Analogue i/p
9	DO NOT CONNECT TO THIS PIN
10	Sync.
11	Ready
12	D13
13	D12
14	D11
15	D10
16	D9
17	D8
18	D7
19	WR
20	+ 15V (power)
21	- 15V (power)
22	0V
23	Int Output
24	Position Monitor (Pos Mon)
25	0V (Analogue)
26	-ve Analogue i/p
27	DO NOT CONNECT TO THIS PIN
28	0V (Digital)
29	Out of Range (overload)
30	D0
31	D1
32	D2
33	D3
31	D1
32	D2
33	D3
34	D4
35	D5
36	D6
37	CS

D0 to D13, CS (chip/module select) and WR (write or data valid) are internally pulled down to 0V via 100kΩ resistors.

0V (Analogue), for referencing analogue signals, and 0V (Digital) for referencing digital signals, are internally connected ("star pointed") to 0V (power).

3.3 Bar Graph Reference and Range O/P

The bar graph reference and range o/p are for use with the AX101 / AX301 host units.

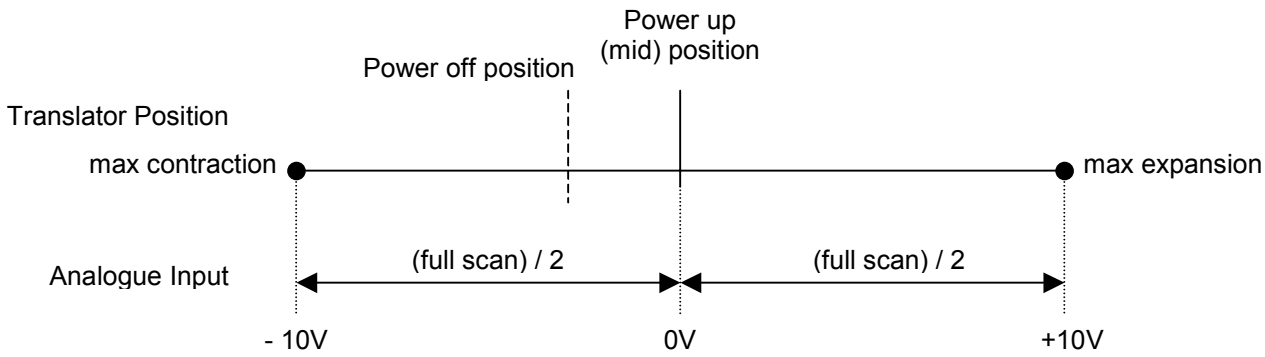
3.4 Analogue I/P

Application of a differential voltage across pins 8 and 26 of the connector will enable the user to control the DPT-C position. The differential voltage should be between -10V and +10V.

If the DPT-C is to be driven from a single ended (i.e. non-differential) source, then one of the inputs should be grounded. By swapping the positive and negative connections, the sign of the DPT-C scan function will be changed (see figure 7). Please note that this is a very sensitive input and a stable low noise source should be used.

If a more positive voltage is applied to pin 8 with respect to pin 26, then the DPT-C will expand whilst a more negative voltage will cause the DPT-C to contract.

Figure 7: Translator Position vs. Analogue Input



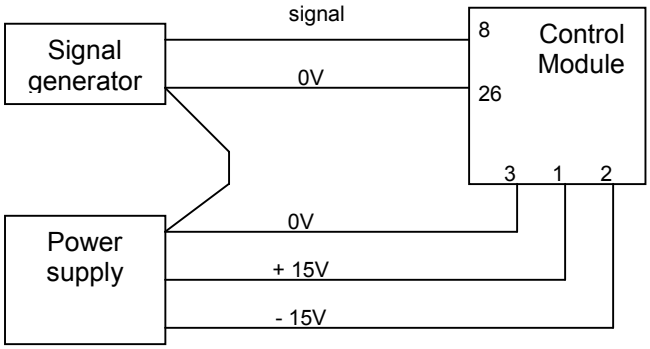
The input impedance is approximately 100kΩ.

The maximum voltage that can be applied to either input is 14V with respect to 0V.

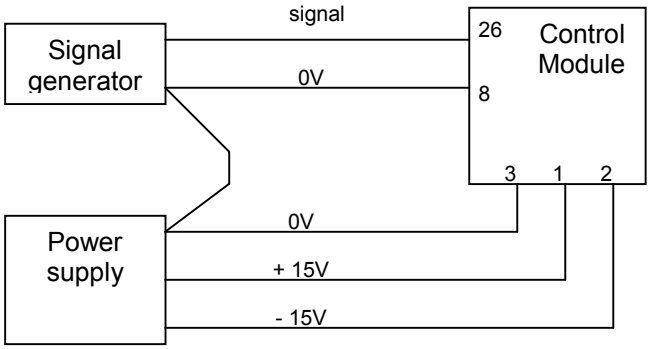
Exceeding this voltage may damage the module.

Figure 8: Examples of Analogue Input Connection

Figure 8a: Single Ended Input

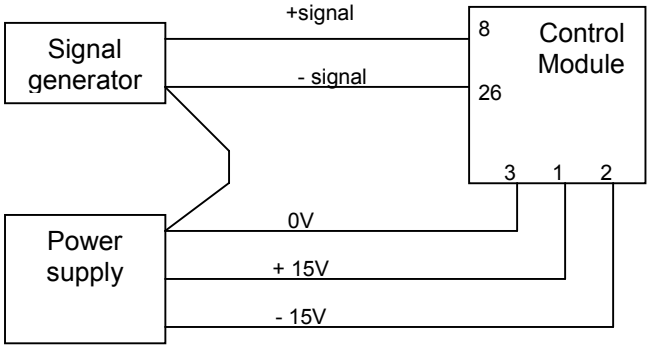


The positive analogue input makes the DPT-C expand

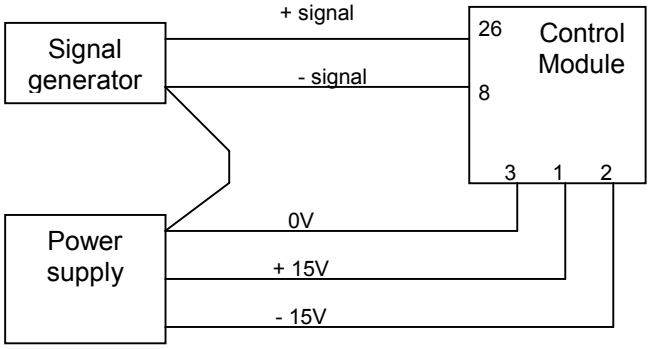


The negative analogue input makes the DPT-C contract

Figure 8b: Differential Input



The positive analogue input makes the DPT-C expand



The negative analogue input makes the DPT-C contract

Note:
0V connection from the power supply to the signal generator is to maintain the common mode voltage to a safe level.

Pin numbers for the Control Module refers to the pins on the 37-way D-type connector.

3.5 Digital I/P

The CM has a 14-bit Digital to Analogue Converter with inputs labelled D0 to D13, where D13 is the Most Significant Bit (MSB), for scanning the full range of the DPT-C.

Pin designations for the digital interface (D0 to D13, CS and WR) are listed in Table 6.

The digital interface is TTL and CMOS logic compatible.
"Low" level input (logic "0") ≤ 0.8V
"High" level input (logic "1") ≥ 2.4V
Both relative to 0V digital. The input impedance is approximately 100kΩ.

Do NOT exceed + 15V for these inputs with respect to 0V and do NOT take inputs below 0V.

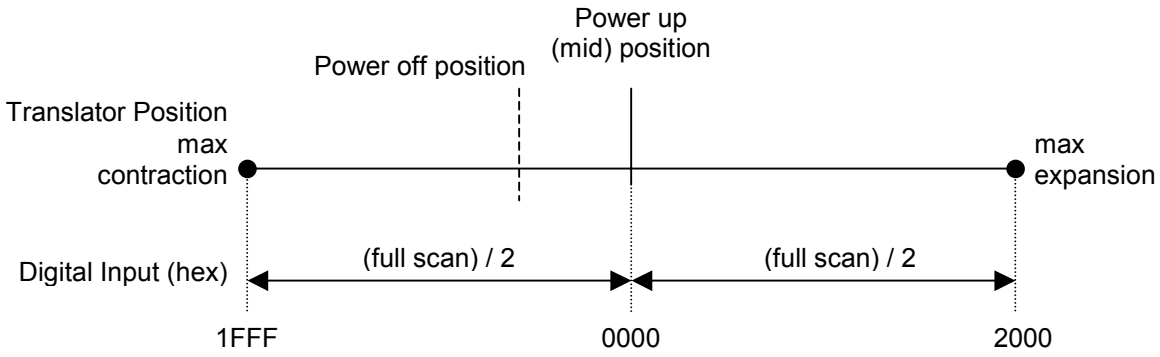
3.5.1 Digital Command Format

Digital input is coded as a Two's Complement number. The MSB is used as a sign bit where "1" indicates a negative number and "0" indicates a positive number.

Table 9: Digital Command Format

Decimal data	**HEX data**	**Binary data**														**DPT-C position**
		D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	
+8191	1FFF	0	1	1	1	1	1	1	1	1	1	1	1	1	1	max contraction - half full scan)
0	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 (nominal / power up position)
-8192	2000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	max expansion - half full scan)

Figure 10: Translator Position vs. Digital Input



3.5.2 Two's Complement Number

Two's Complement number is a bipolar binary code in which positive and negative codes of the same magnitude sum to all zeros plus a carry.

The two's complement is obtained by complementing the number and adding one LSB (Least Significant Bit), i.e. 1.

Table 11: Example of a Two's Complement Number

	Decimal	**Hex**	**Binary data**													
			D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
+3 (hex 0003) is represented by	3	0003	0	0	0	0	0	0	0	0	0	0	0	0	1	1
complementing +3 gives			1	1	1	1	1	1	1	1	1	1	1	1	0	0
1 LSB (hex 0001) is represented by:			0	0	0	0	0	0	0	0	0	0	0	0	0	1
-3 = (complement of +3) + 1 =			1	1	1	1	1	1	1	1	1	1	1	1	0	1
			3			**F**			**F**				**D**			

An example of data sequence required to scan from +3 to -3 is shown in Table 12.

Table 12: Example of Digital Scan Format

Decimal data	**Hex data**	**Binary data**												
		D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
3	0003	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2	0002	0	0	0	0	0	0	0	0	0	0	0	0	1	0
1	0001	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-1	3FFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1
-2	3FFE	1	1	1	1	1	1	1	1	1	1	1	1	1	0
-3	3FFD	1	1	1	1	1	1	1	1	1	1	1	1	0	1

Note:
Both CS (chip/module select) and WR (data valid) signals must be low in order for data to be transferred to the output (i.e. to move the actuator). There is an internal pull down inside the module and therefore if no connections are made to these pins then any data appearing on the input will be transferred to the output.

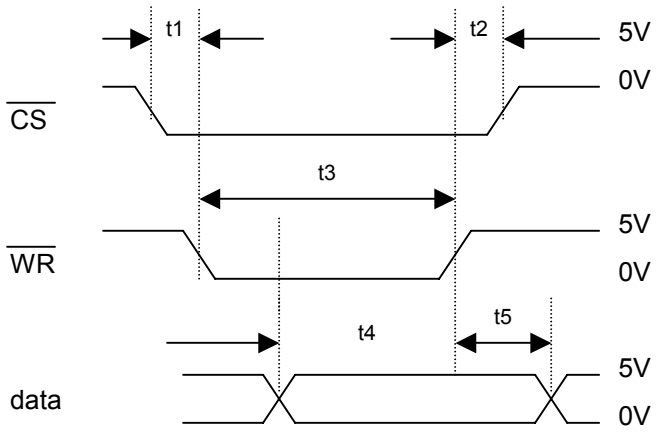
It is recommended that WR signal be used to get Glitch-free operation.

3.5.3 Digital Interface Timing Diagram.

When CS and WR signals are both LOW ("0"), then the data appearing at the CM internal Multiplying Digital to Analogue Converter (MDAC) is transferred to the MDAC output causing DPT-C to move to the digitally commanded position.

When either the CS, WR or both of the signals go HIGH ("1"), the data immediately before this operation is latched into the MDAC output buffers. Any further changes, whilst CS and/or WR signals are HIGH, in the data will NOT be transferred to the MDAC output, hence NO change in the DPT-C position.

Figure 13: Digital Interface Timing Diagram



Parameter	Limit (minimum)	Comment
t1	0ns	CS to WR set-up time
t2	0ns	CS to WR hold time
t3	240ns	Write pulse width
t4	180ns	Data set-up time
t5	30ns	Data hold time

MDAC used is ANALOG DEVICES part No. AD7538JN (14-bit, parallel input DAC).

(**Note**: LDAC input is held LOW inside the CM).

3.5.4 Computer based Digital I/O cards

There are numerous digital I/O cards, available from many manufacturers, which plugs into an expansion slot of a computer. This allows the computer to interface (output and "read in" digital bits) to and from external peripherals, under software control.

3.5.4.1 PC-DIO-24

An example of a Digital I/O card is the National Instruments (NI) part reference PC-DIO-24 (for IBM PC/XT/AT and compatible computers). A similar card exists for Macintosh NuBus computers, Reference # NB-DIO-24.

Table 14: National Instruments Computer-based Digital I/O Card

Reference # / Description	Part #
PC-DIO-24 computer card and N.I. SOFTWARE.	776247-01
NB-DIO-24 computer card and N.I. SOFTWARE.	776159-01

The PC-DIO-24 card can be set for 3 modes of operation (see NI manual). For this application, the PC-DIO-24 card is to be used in **MODE 0** (for simple I/O operations) where OUTPUTs are latched but the INPUTs are NOT latched.

DIO-24 Card Port Configuration		
PORT A	(PA0 - PA7)	OUTPUT
PORT B	(PB0 - PB7)	OUTPUT
PORT C	(PC0 - PC3)	OUTPUT
	(PC4 - PC7)	INPUT

To set the ports as above in MODE 0, the **CONTROL WORD** is:

88 Hex (1 0 0 0 1 0 0 0)

See National Instruments Manual for further information.

3.5.4.2 PC241CM Cable Assembly

A cable assembly is available from Sifam Instruments, which interfaces the PC-DIO-24 and NB-DIO-24 cards in the computer to the CM. Sifam Instruments's part # for the cable assembly is PC241CM.

This cable assembly provides all the necessary digital interfacing required, the ±15V, 0V power connections and Analogue input.

Table 15: PC241CM Interface Cable Assembly

PC-DIO-24 PORT / BIT	PC-DIO-24 Pin #	37-way CM Pin #	Input/Output wrt PC-DIO-24	Signal Name
PB 0	31	30	OUTPUT	D0 (LSB)
PB 1	29	31	OUTPUT	D1
PB 2	27	32	OUTPUT	D2
PB 3	25	33	OUTPUT	D3
PB 4	23	34	OUTPUT	D4
PB 5	21	35	OUTPUT	D5
PB 6	19	36	OUTPUT	D6
PB 7	17	18	OUTPUT	D7
PA 0	47	17	OUTPUT	D8
PA 1	45	16	OUTPUT	D9
PA 2	43	15	OUTPUT	D10
PA 3	41	14	OUTPUT	D11
PA 4	39	13	OUTPUT	D12
PA 5	37	12	OUTPUT	D13
PA 6	35	----------	OUTPUT	NOT USED
PA 7	33	----------	OUTPUT	NOT USED
PC 0	15	19	OUTPUT	WR
PC 1	13	37	OUTPUT	CS
PC 2	11	----------	OUTPUT	NOT USED

PC-DIO-24 PORT / BIT	PC-DIO-24 Pin #	37-way CM Pin #	Input/Output wrt PC-DIO-24	Signal Name
PC 3	9	----------	OUTPUT	NOT USED
PC 4	7	11	INPUT	READY
PC 5	5	29	INPUT	OUT OF RANGE
PC 6	3	28	INPUT	0V
PC 7	1	28	INPUT	0V
0V	50	28	SIGNAL RTN	0V(D)
----------	CABLE SCREEN	28	N/A	0V(D)
POWER CONNECTIONS				
----------	----------	1	----------	+15V power
----------	----------	2	----------	-15V power
----------	----------	3	----------	0V power
ANALOGUE INPUT				
----------	----------	8	----------	+ANA I/P
----------	----------	26	----------	-ANA I/P

3.6 Position Monitor

The position monitor, available at pin 24 on the 37-way D-type connector, will give a value from -5V to +5V proportional to the DPT-C position

MAX EXTENSION = +5Vdc
MAX CONTRACTION = -5Vdc

The DPT-C position can be obtained by using the multiplying factors shown in Table 3.8.

Table 16: Position Monitor Scale Factors

Translator type	Total range (Factory set)	Position in µm
DPT-C-S (15µm)	16µm	1.60 x position monitor output
DPT-C-M (35µm)	37.5µm	3.75 x position monitor output
DPT-C-L (70µm)	75µm	7.50 x position monitor output

Position monitor is accurate to 1% and is only valid whilst the actuator is static and if the Out of Range signal is not active (i.e. LOW or "0").

The position monitor is **NOT** accurate dynamically and the INT output should be monitored to indicate the behaviour of the actuator.

3.7 Out of Range

The Out of Range signal, available at pin 29 on the 37-way D-type connector, is active during slewing transient, a fault condition or if the command input demands more high voltage range than is available (This signal used to be called Overload).

"Normal operational" level	≤	0.8V ("0")
"Out of Range" level	≥	2.4V ("1")

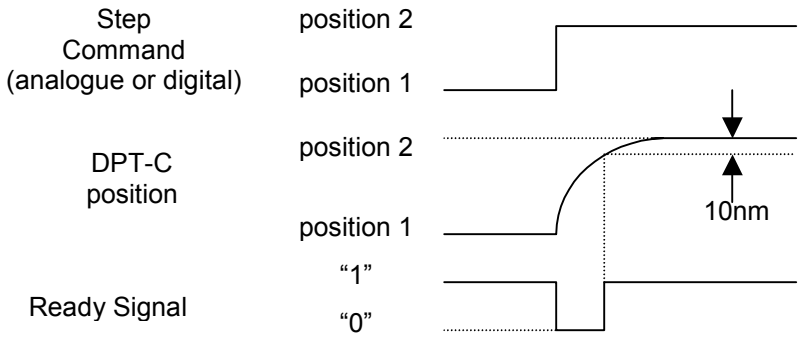
Current sink capability (low level) = 15mA maximum
Current source capability (high level) = 0.5mA maximum

3.8 Ready

Ready signal, available at pin 11 on the 37 way D-type connector, is HIGH, "1" (≥ 2.4V) when the detected DPT-C position is approximately 10nm from the commanded position.

If the DPT-C position is greater than 10nm from the commanded position, then the ready signal is LOW, "0" (≤ 0.8V).

Figure 17: Ready Signal



3.9 INT Output (Integrator Output)

This is factory set and should only be adjusted if there are problems scanning the actuator over its full range. INT output can be monitored on pin 23 of the 37-way D-type interface connector.

This is used for setting the nominal (mid-range) position of the actuator. Nominal position of the actuator must be set in order to expand and contract the actuator by equal amounts.

This is the input for the CM high voltage amplifier, which drives the piezo. Therefore INT output will **NOT** show the position of the actuator whilst static, as this signal compensates for approximately 20% piezo hysteresis and for piezo creep, but will show dynamic behaviour of the actuator.

INT output signal is used to determine the closed loop frequency response (bandwidth) of the CM / DPT-C by applying a small signal sine wave to the analogue input and measuring the 3dB point of the INT output.

INT output also shows the amount of high voltage that is available for scanning. The actuator will remain under servo control whilst the INT output is between approximately - 10V and + 6V.

3.9.1 Setting Nominal Position

This is factory set and should only be adjusted if there are problems scanning the actuator over its full range. Nominal position of the actuator must be set in order to expand and contract the actuator by equal amounts.

Note:
This may also be required if the actuator is pre-loaded.

To see if the CM / DPT-C system requires this adjustment, perform the following tests.

1. Apply + 10V analogue input or Digital input of 2000 Hex.

   Monitor Out of Range signal, available at pin 29 on the 37-way D-type connector, and ensure that the signal is LOW.

2. Change Analogue input to – 10V or Digital input to 1FFF Hex.

   Monitor Out of Range signal and ensure that the signal is LOW.

If the Out of Range signal is HIGH for either step (1) or (2), then remove the Analogue and Digital input and reset the INT output to – 2.0V ± 0.5Vdc. Check set up using steps (1) and (2) again.

To set the nominal position, set analogue input to zero (0V) and digital input to zero (0000).

Note:
Disconnecting analogue input connections and digital input connections will default to zero command.

Monitor INT output signal at pin 23 on the 37-way D-type connector, with respect to 0V at pin 7 on the 37-way D-type or 0V at the power supply with a DVM set to 20V dc range or an oscilloscope.

Adjust the potentiometer accessible through the sidewall (see figure18), position referenced as "Adjustment Potentiometer", until the INT output is set to – 2.0V ± 0.5Vdc. This is the nominal position of the actuator.

Check that the system is set up correctly by repeating steps (1) and (2) above.

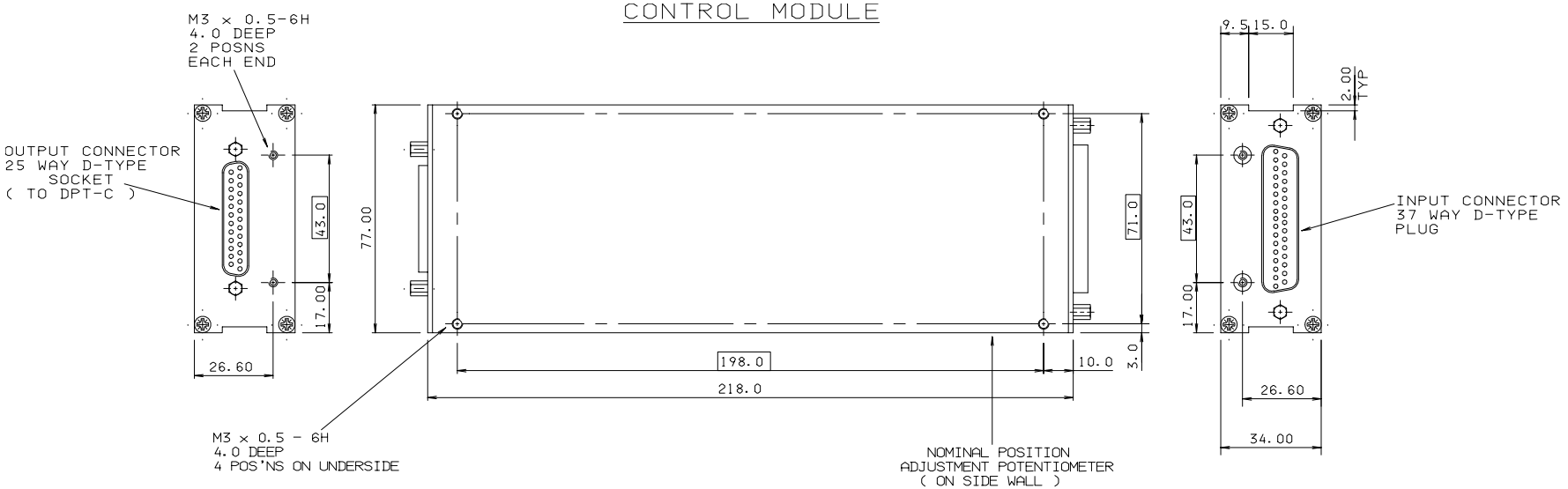
If the Out of Range signal is HIGH for either step (1) or (2), then repeat the set up procedure.

Note:
When power is turned off and on again, the INT output will change. This is due to the hysteresis in the piezo material.

The gap will remain the same as the difference in the INT output is proportional to the hysteresis and is the amount of high voltage required to maintain a constant gap.

Page 26 shows the Control Module installation Drawing and Adjustment Potentiometer Position (Figure 18).

CONTROL MODULE



ALL DIMENSIONS ARE IN mm.

4 Control Module Synchronisation

When one or more Control Modules are operated from the same power supply, then noise may be introduced from one module to the other. This is due to the 30kHz oscillators in each module having slightly different frequencies causing "beating" effects.

This can be eliminated by using one Control Module (MASTER) producing the 30kHz reference signal and the other modules (SLAVES), which have their oscillators disabled, use this reference signal.

When the Control Modules are set up, **pin 10 of the 37-way D-type connector** is used to distribute the reference signal from the MASTER module to the SLAVE module(s).

4.1 Master Module Configuration

a) **Disconnect power cable from the Control Module.**
b) Remove CM lid (by removing 4 screws - 2 on each side).
c) Move link from LNK11B (SLAVE) to LNK11A (MASTER) on "bottom or main" PCB - see figure 19.

   Note:

   LNK11A - MASTER is populated at the factory unless specifically set as "SLAVE" module.
d) On "TOP" PCB, move LNK1 from "STD" to "SYNC".
e) Replace the CM lid.

4.2 Slave Module Configuration

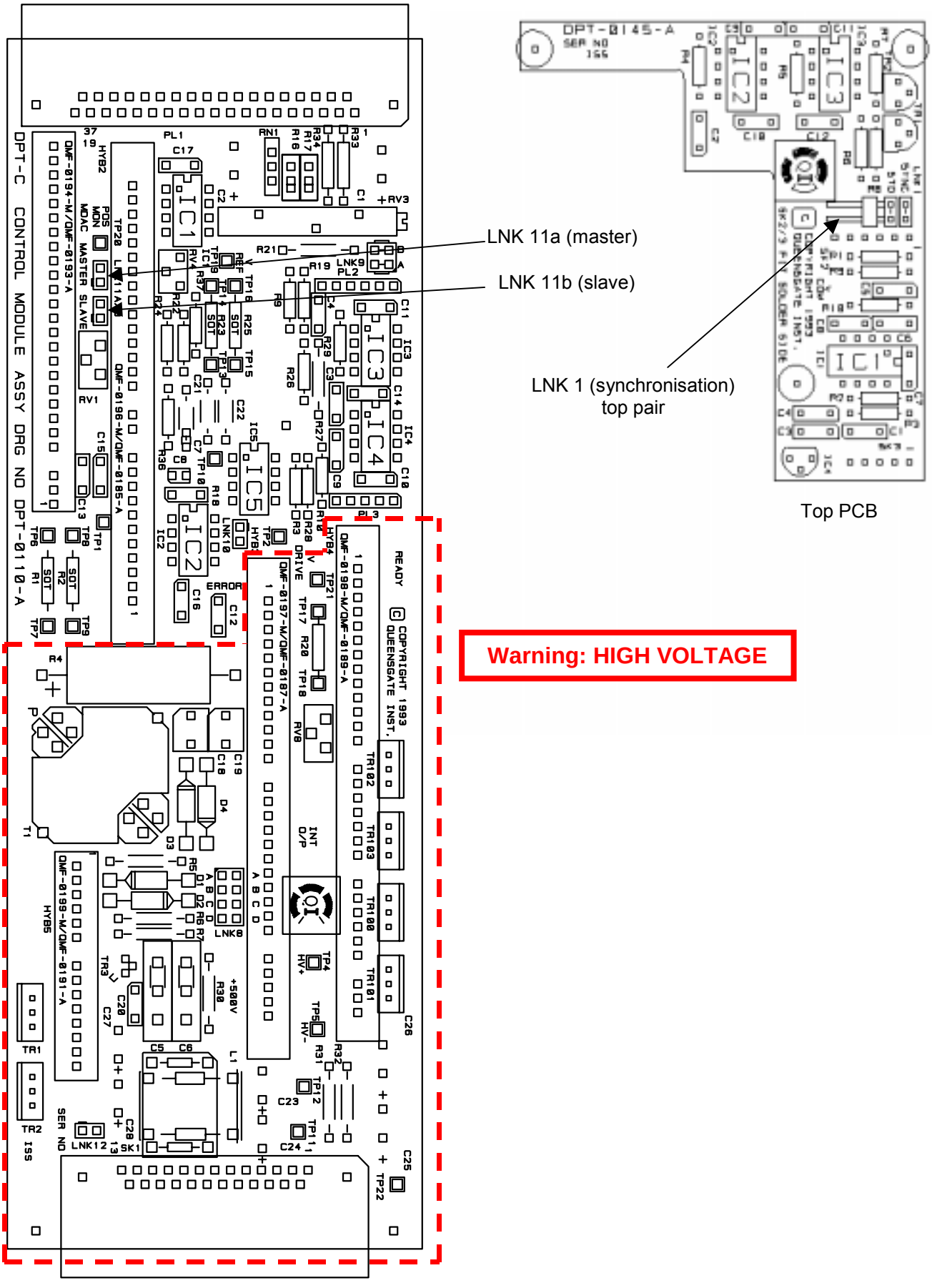
a) **Disconnect power cable from the Control Module.**
b) Remove CM lid (by removing 4 screws - 2 on each side).
c) Move link from LNK11A (MASTER) to LNK11B (SLAVE) on "bottom or main" PCB - see figure 19.
d) On "TOP" PCB, move LNK1 from "STD" to "SYNC" - see figure 19.
e) Replace the CM lid.

4.3 Master/Slave Operation

Connect pin 10 of MASTER module to pin 10 of **ALL** the SLAVE modules on the 37-way D-type connector(s).

DO NOT have more than one MASTER module as damage to the modules may occur.

Figure19: Identification of Synchronising Link Positions



5 Using the DPT-C with the CM

A cable is provided with each CM to enable DPT-C operation using the analogue input. The cable has the following connections.

Table 20: SDLQ-supplied "CM Power" Cable

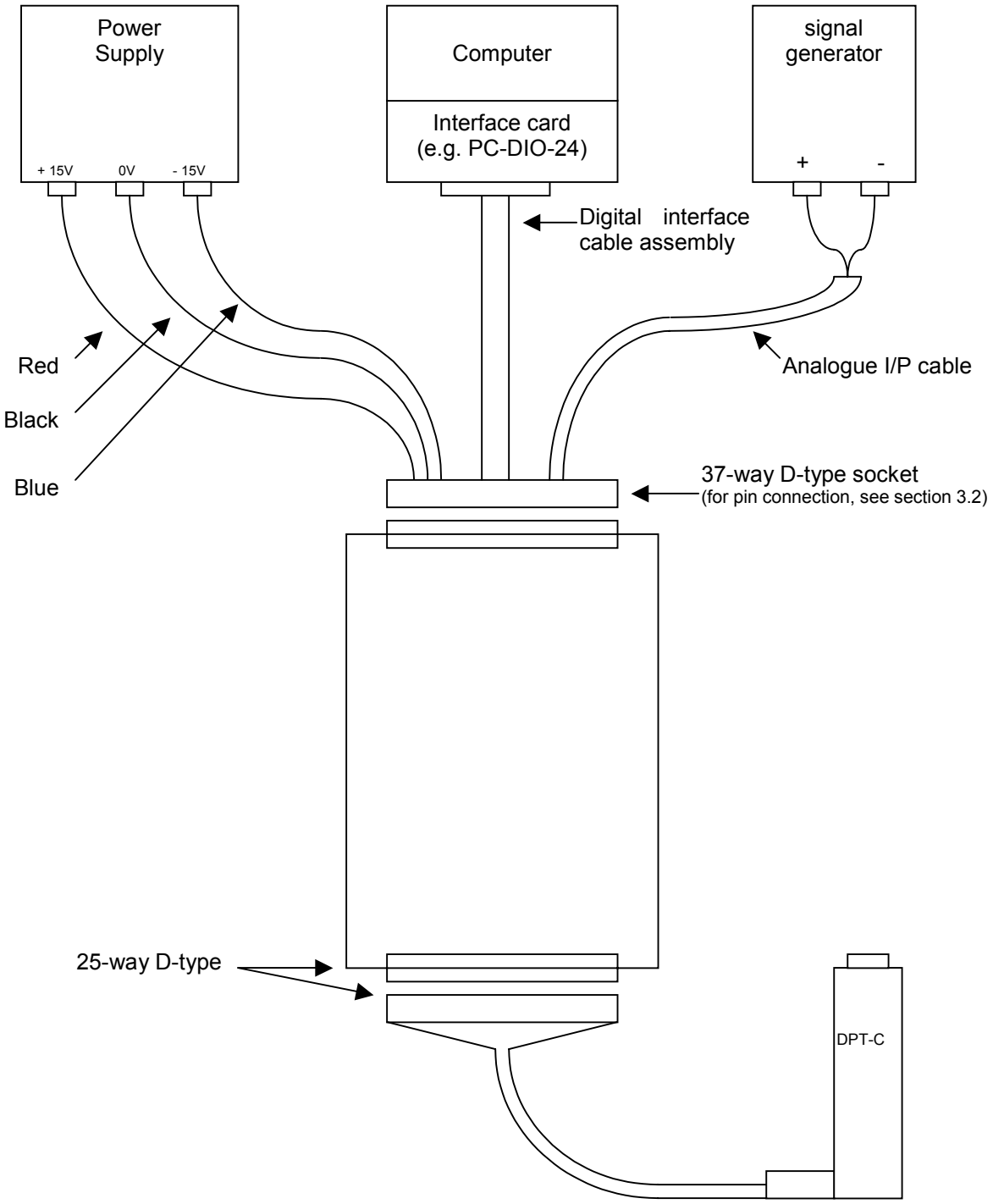
Function	Cable Type	Cable Termination	Wire colour	37-way D-type pin #
Power Connections				
+ 15V Power	16/0.2 wire	4mm banana plug	Red	1
- 15V Power	16/0.2 wire	4mm banana plug	Blue	2
0V POWER	16/0.2 wire	4mm banana plug	Black	3
Analogue Input				
+VE analogue I/P	2 core coaxial	Flying lead	Brown/Clear	8
-VE analogue I/P	2 core coaxial	Flying lead	Green	26
Screen	2 core coaxial	Flying lead	Braid	No Connection

Warning:
DO NOT CONNECT OR DISCONNECT THE DPT-C WHILST THE MODULE IS POWERED UP - DAMAGE TO MODULE AND/OR ACTUATOR MAY OCCUR.

5.1 Connecting the Control Module to the DPT-C and the Power Supply

a) Connect CM to the 37-way D-type SDLQ-supplied cable assembly.
b) Connect DPT-C to the CM, via the 25-way D-type.
c) Set power supply outputs to give ± 15V outputs.
d) Switch OFF power supply outputs.
e) Connect 4mm BLACK banana plug to the 0V terminal of the power supply.
f) Connect 4mm RED banana plug to the + 15V terminal of the power supply.
g) Connect 4mm BLUE banana plug to the - 15V terminal of the power supply.
h) Connect Analogue Input cable to a signal generator (see figure 8).
i) Switch ON power supply.
j) The DPT-C can now be scanned using the signal generator, via the Analogue input.
k) Check for correct operation by measuring the current consumption. Expected to be between 190mA and 250mA with zero Analogue and Digital commands.

Figure 21: Connecting the Control Module to the DPT-C



Standard cable assembly supplied with ALL Control Modules consists of power supply connections and analogue input cable.

PC241CM Cable Assembly
PC241CM cable assembly consists of power supply connections, analogue input cable and digital interface cable/connector to mate with PC-DIO-24 (or NB-DIO-24).

6 Trouble Shooting

Due to the presence of High Voltage (up to 550Vdc) inside the control module, trouble shooting is limited to functional check only by monitoring signals on the 37-way D-Type connector.

DO NOT REMOVE THE CONTROL MODULE COVER OR DISCONNECT THE ACTUATOR FROM THE MODULE.

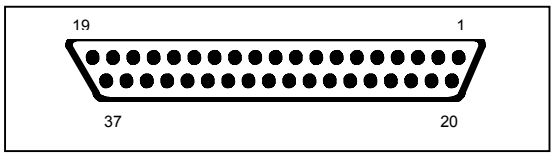
6.1 Test Equipment

Voltmeter (with input impedance >500kΩ).
15Vdc power supply.
Signal generator (if using Control Module analogue interface).
Computer with digital I/O (if using Control Module digital interface).

All signals that need to be monitored in section 6.2 are available on the 37-way D-type cable connector **(socket).**

Remove the 37-way D-type cable connector shell, to monitor signals stated in this section. Additional wires may be added to the relevant pins for ease of monitoring.

Pin numbering on the 37-way D-type cable connector is (looking at the socket contacts on the cable connector, i.e. face mating with CM plug):



See section 3.2 page 16 for pin designation for the 37-way D-type cable connector (and on the CM).

6.2 Signal Verification

This section verifies that the connector is wired up correctly and checks that the signals are getting to the correct pin on the connector.

6.2.1 15V supply

a) Disconnect the 37-way D-type cable connector from the Control module.
b) Set voltmeter to 20V dc scale.
c) Connect a voltmeter between pins 1 and 3 on the cable connector (voltmeter common should be connected to pin 3 on the 37-way D-type cable connector).

d) Connect the three-power input cables to the ±15V power supply.

RED PLUG	+15V
BLUE PLUG	-15V
BLACK PLUG	0V

e) Switch on power supply.

f) Measure the voltage. Should be **+15V** ±0.5Vdc.

g) Connect the voltmeter between pins 2 and 3 (voltmeter common).

h) Measure the voltage. Should be **-15V** ±0.5Vdc.

i) Switch OFF the power.

6.2.2 Analogue input

j) If analogue input is used, then:

i) Connect the GREEN wire and the screen of the analogue input cable from the 37-way D-type cable connector to the negative or common output of the signal generator.

ii) Connect the CLEAR or BROWN wire on the analogue input cable from the 37-way D-type cable connector to the signal output of the signal generator.

iii) Connect the voltmeter common to pin 26 and the voltage input probe to pin 8 of the 37-way D-type cable connector.

iv) Set voltmeter to 20V dc scale. Set signal output to give +5V 0.5Vdc.

v) Voltmeter should read +5V 0.5Vdc (i.e. same as signal generator output).

6.2.3 Digital input

k) If digital input is used, then

i) Connect the computer digital interface to the 37-way D-type cable connector.

ii) Set voltmeter to 20V dc scale. Connect the voltmeter common to pin 10 of the 37-way D-type cable connector.

iii) Monitor data pins on the 37-way D-type cable connector with various commands as stated in the table below. Ensure that the measured logic levels and the bit patterns are correct.

Logic "0" is between 0V and 0.8Vdc. Logic "1" is between 2.4V and 5.5Vdc.

37-way D-type	Binary data														Check
Pin No. ⟶	12	13	14	15	16	17	18	36	35	34	33	32	31	30	
HEX DATA	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	
0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0001	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0002	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
0004	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
0008	0	0	0	0	0	0	0	0	0	0	1	0	0	0	
0010	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
0020	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
0040	0	0	0	0	0	0	0	1	0	0	0	0	0	0	

37-way D-type Pin No. →	Binary data														Check
	12	13	14	15	16	17	18	36	35	34	33	32	31	30	
0080	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
0100	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
0200	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
0400	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
0800	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
1000	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
2000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
1FFF	0	1	1	1	1	1	1	1	1	1	1	1	1	1	

iv) If the CS and the WR lines are used, then with the voltmeter common connected to pin 10 of the 37-way D-type cable connector, monitor the CS line, pin 37.

v) Set the CS line low ("0") via the computer. The voltage level should be between 0V and 0.8Vdc.

vi) Set the CS line high ("1") via the computer. The voltage level should be between 2.4V and 5.5Vdc.

vii) Monitor the WR line, pin 19.

viii) Set the WR line low ("0") via the computer. The voltage level should be between 0V and 0.8Vdc.

ix) Set the WR line high ("1") via the computer. The voltage level should be between 2.4V and 5.5Vdc.

If any of the connections are incorrect or faulty, then correct the connections and verify as above.

6.3 Monitor Pins

This section checks whether the actuator / Control Module is functioning correctly.

a) Ensure the Power supply, Analogue input and Digital inputs are **ALL OFF**.

b) Connect the 37-way D-type cable to the control module. Also connect the actuator to the control module.

c) Connect the Voltmeter common to pin 7 (0V) on the 37-way D-type connector.

d) Switch on the power.

e) Monitor the signal levels on pins 23 (INT O/P) and 29 (Out of Range) using a Voltmeter.
During normal operation, and with analogue = 0V and digital = 0000, the following signal levels will be present.

	Signal name (PIN #)	Expected voltage	Measured level
i)	Out of range (pin 29)	between 0 and 0.8Vdc	
ii)	INT O/P (pin 23)	- 2V ± 0.5Vdc	

f) If the above signal levels are not within the limits, then the actuator mid position is not correct. One reason could be that the nominal or power up position could have shifted due to vibration. This can be reset by carrying out the following procedure.

g) Set analogue input to zero (0V) and digital input to zero (0000). Disconnecting analogue input and digital input defaults to zero command.

h) Connect the Voltmeter common to pin 7 (0V) on the 37-way D-type connector and the voltmeter input probe to pin 23 (INT O/P) of the 37-way D-type connector.

i) Adjust the potentiometer accessible through the sidewall, adjustment potentiometer, until the INT output is greater than +10Vdc. The actuator at this point should be fully contracted.

j) Adjust the potentiometer until the INT output is less than - 10V, at his point the actuator should be fully expanded.

k) Adjust the potentiometer accessible through the sidewall until the INT output is set to -2.0V 0.5V dc. This is the nominal position of the actuator.

l) If the INT output can be set to -2V 0.5V dc, then the Control module / DPT-C can be used as normal without effecting the POS MON, analogue and digital input scale factors.

If this does not fix the fault, please contact either the agent who supplied the equipment or Sifam Instruments directly. For Address and telephone numbers, see section 7.

7 Sifam Instruments After-Sales Office

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