Storm
data entry technology

420 Series RS232 only Encoder for Keypad Applications
Application / Engineering Manual

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Section 1. Table of Contents

Section 2. Overview

Storm 420 Series Encoders allow interfacing between keypad and host system, and are supplied either as a separate encoder module or are pre-built into a Storm keypad system to suit end user requirements.

Features / Specifications

- *Input Power + 5V ± 0.25V dc*
- *RS232 Output via 6 pin Molex 2.54mm (.100") Pitch KK®*
- *drives Powertips 80 Character LCD Display from keypad*
- *direct connection to underpanel mounted 12 way, 16 way, 20 way Storm Keypads.*
- *Ribbon Cable needed for top panel fixing   4, 12 , 16 way Storm Keypads*
- *Overall Footprint 89mm x 66mm*

Electromagnetic Compatibility (EMC)

Storm 400 Series Encoders are classified as a component with regard to the European Community EMC regulations and it is the users responsibility to ensure that systems using the board are compliant with the appropriate EMC standards.

If the electronic system requires input protection against high voltage transients (to meet CE requirements) it is recommended that an external interface board is located at the point where the external wiring enters the electronic system enclosure.

Application : Storm Integrated Keyboard/ Display Module with RS232 Encoder

As a combination the Storm Integrated Keyboard/ Display Module with RS232 Encoder fitted forms a complete serial communications device to allow extended numerical input from the user and alphanumeric output from the unit to be communicated via the familiar RS232 physical link layer.

The keypad has 20 keys including ten numeric keys and a further ten special function keys. The LCD module displays 80 characters across 4 lines. Both the keypad and LCD module may be backlit from the controller board.

The module has been designed in such a way that it can be used as part of an embedded application, possibly using a separate host microcontroller or PC to communicate with the module. Alternatively it may be used for human interface since the keypad and LCD functions have been designed to be familiar to most users.

The keypad is arranged as a 5-row, 4 column matrix and is scanned and debounced by the module's built-in microprocessor. The required debounce before a key is recognised as being pressed is 64ms. No typematic key rollover function is implemented. Multi-key lockout is, however, implemented in the firmware.

Application : Add RS232 to a Standard Storm 1000 Series Keypad

The encoder can either be fitted as a direct plug in to the rear of a standard Storm 1000 Series Keypad, or remotely by a ribbon cable of up to 6 inches in length.

Underpanel Mount Keypads - direct plugin, no additional mounting hardware required apart from RS232 cable.

Depth required from keypad backplate is 32mm (1.25in)

Surface Mount Keypads - separate cable and mounting hardware is required (these items not included with encoder)

Section 3. Communications Protocol

Physical Link Layer

The module transmits and receives data using RS232 signalling with a voltage swing of approximately ±9V. DIP Configuration Switch 8 selects between 9600 baud (DIP switch off) and 1200 baud (DIP Switch on). In both cases, 8-bit data is used with no parity and one stop bit. This may be summarised as follows….

DIP8 OFF   9600,8,N,1
DIP8 ON   1200,8,N,1

No software or hardware handshaking is used since the data rate is low relative to the bandwidth of the communications protocol.

Only the TX, RX and Ground signals are employed. The chosen nomenclature is that TX means transmission out of the module.

Data buffering

Both data transmission and reception are controlled by the module's built in microprocessor using a pair of stacks- one for transmitted characters and one for received characters. These allow the application to send data to and from the unit largely without consideration of the timing constraints of the RS232 physical link layer.

Provided the stacks are not filled, data can be freely sent to and received from the module and the module will buffer the characters until such times as it is able to process them.

The buffer sizes are as follows…

Data transmission (keypad data out of module)   16 bytes
Data reception (LCD data into module)   48 bytes

Should the buffers be filled, further characters will not be pushed onto the stacks, but instead are discarded.

Character echoing

Characters received from the host terminal/microprocessor may be echoed back to the host by setting DIP Configuration Switch 2 to ON. With DIP Switch 2 OFF the characters are not echoed.

Characters resulting from key strokes are never echoed to the LCD display, but are simply sent via the RS232 TX pin to the host application.

Section 4. LCD Display

The LCD display comprises 80 characters in all, arranged as 20 characters on each of 4-lines. The full range of standard ASCII characters are available, including lower case letters. Some, but not all, of the extended ASCII characters are available. Appendix 3 lists the available characters.

Power-up message
At power-on the LCD display shows hardware and software version numbers and communications information for a period of approximately 5 seconds. After this time the display automatically clears and the cursor is located at the first character on the left of line 1.

LCD operating principles
The LCD interface is designed to be suitable either for human interface (for example as a data entry terminal) or for embedded microprocessor applications.

It has been designed to operate in a similar way to a teletype terminal since this is a familiar environment to most users and is consequently intuitive.

The cursor begins on the left of line 1. Entered characters move the cursor progressively further to the right of line 1 until the end of the line is reached. Entering one further character automatically moves the cursor to the beginning of line 2, i.e. automatic text wrapping is implemented. This applies to all lines.

Once the end of line 4 is reached, entering one further character results in all lines moving up one place, resulting in the contents line 1 being discarded, line 2 moves to line 1, line 3 moves to line 2 and line 4 moves to line 3. Line 4 is subsequently cleared and the cursor moves to the beginning of line 4.

Special characters
The Carriage Return key is supported (ASCII character 0x0D) and results in the cursor moving to the beginning of the next line, exactly as described above. The Line Feed key (ASCII character 0x0A , or Ctrl-J in HyperTerminal) is also supported and gives the same functionality as carriage return.

The backspace key (ASCII character 0x7F) and Del key (ASCII character 0x08) may be used to delete the last entered character and move the cursor back one place. This can be repeated until the cursor is at the beginning of the current line, but no further (exactly as a teletype terminal).

The Tab key (ASCII character 0x09) is supported, and enters four spaces, even if this involves a line-wrap.

The Form Feed key (ASCII character 0x0C, Ctrl-L in HyperTerminal) is implemented as a 'clear screen' function and returns the cursor to the beginning of line 1..

Section 4 continued. LCD Display

Typical implementations
An embedded application where the LCD is written to by a separate microprocessor or computer would typically send a Form Feed character followed by up to 80 characters, possibly interspersed with carriage returns to reduce the number of characters to be transmitted.

It is unlikely that such as application would make use of the backspace function since there are unlikely to be errors in data entry, although the line-wrap feature may be used to allow the microprocessor to treat the display as a contiguous array of 80 characters with no requirement for carriage returns.

A terminal-like application, however, where the user is permitted to type any characters on the LCD (perhaps using an application such as HyperTerminal) would almost certainly make use of all the features built into the module such as line-wrap and special characters to make the interface more user friendly.

LCD adjustment
A potentiometer is provided on the module interface circuit board to allow the contrast of the LCD display to be adjusted.

Supported Displays

POWERTIP TECHNOLOGY CORP.
20 Char x 4 Line Display PC 2004LRU-AWA-H, PC 2004LRU-ASO-H , PC 2004LRU-AEA-B or equivalents

Pin	Symbol	Function
1	Vss	Power supply(GND)
2	Vdd	Power supply(+)
3	Vo	Contrast Adjust
4	RS	Register select signal
5	R/W	Data read / write
6	E	Enable signal
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
15	A	Power supply for LED B/L (+)
16	K	Power supply for LED B/L ( )

## Part Numbering Scheme

Product Code	Description
4200-00[x]	RS232 ENCODER, KEYMAT STD, NO CABLE
4200-001-0398	RS232 ENCODER CUSTOM INP398
4200-01[x]	RS232 ENCODER, KEYMAT STD, 0.23m CABLE
4200-02[x]	RS232 ENCODER, KEYMAT STD, 2.0m CABLE

For standard products the Product Code is shown on the label on the encoder. The (non-upgradeable) firmware version is shown on the back of the controller eg Version 5.01 (or alternatively 5v01)

Packaging variant denoted by [x] - contact your Storm distributor for details.

Appendix 1. Connection Details

RS232 Cable Pinout Connection

NC

NC

RTS

NC

GND

DTR

RX

TX

NC

Remove earth wire on keypads

TX (Pin 1)

RX

RTS

NC

GND

DTR
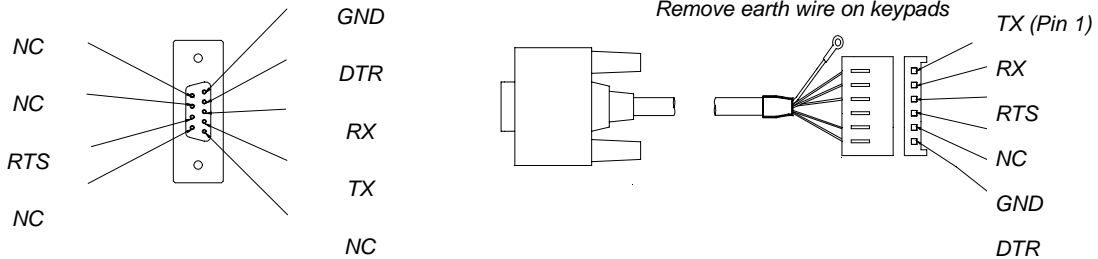
Encoder Connections

| Keypad Connector *(on reverse of pcb)*														✓ = pin connection made		Direct connection to rear of keypad ?
KEYPAD TYPE																
20 WAY BACKLIT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			**YES**
20 WAY NOT BACKLIT *Fit polarising pin*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*Fit polarising pin*			**YES**
12 / 16 WAY BACKLIT *Fit polarising pin*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*Fit polarising pins*				**YES** —fit polarising pins to positions 1,12 and 13
12 / 16 WAY NOT BACKLIT *Fit polarising pins*			✓	✓	✓	✓	✓	✓	✓	✓	*Fit polarising pins*					**YES**
4 WAY BACKLIT *Fit polarising pin*		✓	*Fit polar- ising pin*	✓	✓	✓	✓				✓	*Fit polaris- ing pin*	✓			**NO** —separate cable required STD version needs 5 way cable BACKLIT version needs 7 way cable Fit polarising pins as required
4 WAY NOT BACKLIT *Fit polarising pins*				✓	✓	✓	✓				✓	*Fit polarising pins*				

R = ROW, C = COLUMN

Encoder Pin	1	2	3	4	5	6	7	8	9	10	11	12	13
To Keypad	LED CATHODE	TAMPER IN	R1	R2	C1	C2	C3	C4	R4	R3	R5 FUNCTION KEYS	TAMPER OUT	LED ANODE

PIN 1 ON REVERSE

RS232 OUTPUT
TX (Pin 1)
RX
RTS
NC
GND
DTR

JUMPER CONTROLS LED COLOUR

RED

GREEN

JP8 FACTORY USE ONLY

Power Terminals

LCD Contrast Adjustment

PRODUCT CODE

FIRMWARE VERSION

Keymat Technology
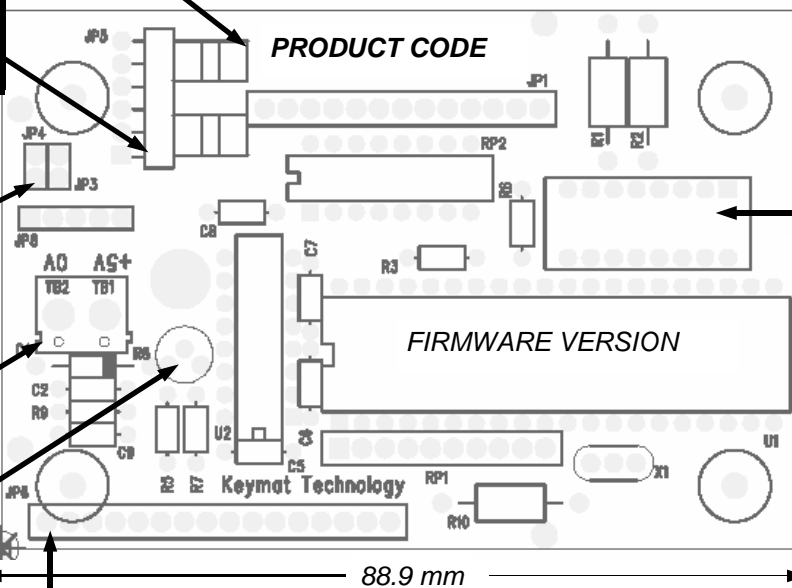
60 mm

88.9 mm

Configuration Switch

LCD Connector, 16 pins, 0.1" square pins

Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Symbol	Vss	Vdd	Vo	RS	R/W	E	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	A	K

Appendix 2. Configuration Switch Options - Keytop Legends / ASCII Codes

Configuration Switch Settings	1	2	3	4	5	6	7	8
4 Way Keypads	ON	CHARACTER ECHOING SELECTOR ON = ECHO ON OFF = ECHO OFF	OFF	ON	ON	ON	OFF	BAUD RATE SELECTOR OFF=9600 BAUD ON=1200 BAUD

Installation Checklist

✓Keypad
✓Encoder , configuration switch set
✓Panel Fixing prepared
✓+5V regulated supply
✓RS 232 cable with 6 way Molex socket
✓Ribbon cable keypad to encoder if needed
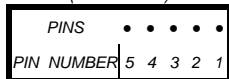✓LCD and 16 way ribbon cable if needed
✓Polarising pins fitted to encoder

4 way Cursor   *4 way Function*

R5   *R5*

C1

C2

C3

C4
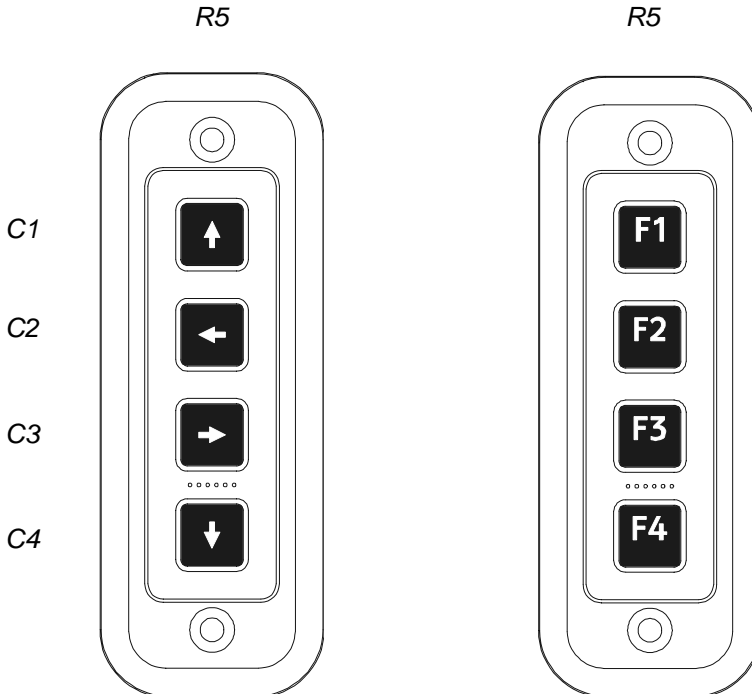
Cable Connections for 4 way keypads

ENCODER PIN	TO	KEYPAD PIN	
		STD	BACK-LIT
2		NC	1
11		1	2
5		5	6
6		4	5
7		3	4
8		2	3
13		NC	7

4 WAY KEYPAD CONTACT CONNECTIONS (REAR VIEW)

PINS • • • • •
PIN NUMBER 5 4 3 2 1

CONTACT MATRIX

PIN	ROW / COLUMN
1	R5
2	C4
3	C3
4	C2
5	C1

4 WAY BACKLIT KEYPAD CONTACT CONNECTIONS (REAR VIEW)

PINS • • • • • • •
PIN NUMBER 7 6 5 4 3 2 1
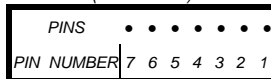
CONTACT MATRIX

PIN	ROW / COLUMN
1	LED POWER
2	R5
3	C4
4	C3
5	C2
6	C1
7	LED POWER

ASCII CODES

ROW/ COLUMN	R5
C1	11
C2	12
C3	13
C4	14

NOTE 1 : These codes are non-printing ASCII device control codes. The application software will need to assign usage
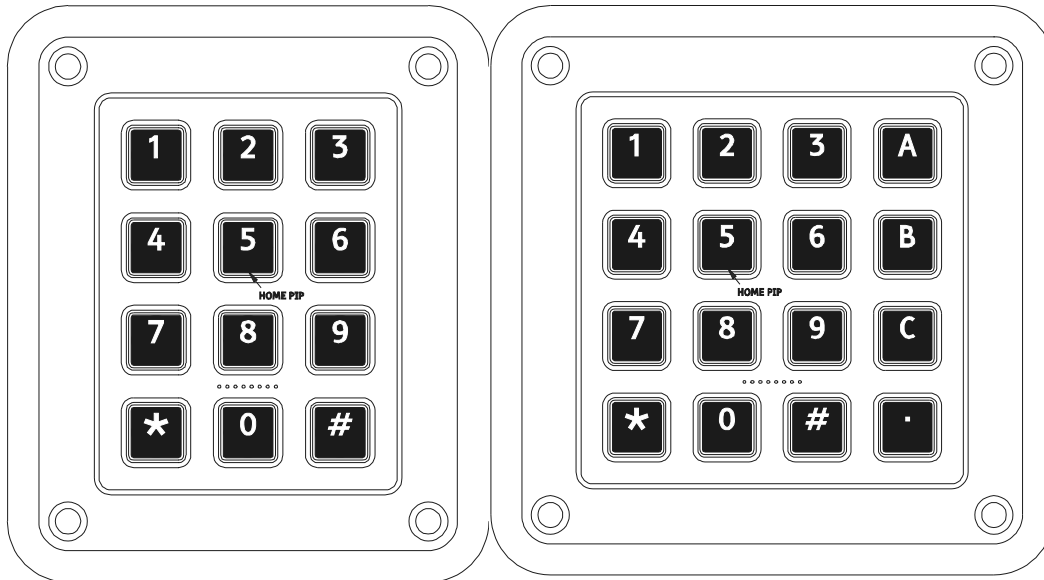
NOTE 2 : The COMMON pin on a 4 way is termed ROW 5 to be consistent with applications using 4 function keys.

Appendix 2. Configuration Switch Options - Keytop Legends / ASCII Codes

Configuration Switch Settings	1	2	3	4	5	6	7	8	Installation Checklist
12 and 16 Way Telephone Layout Keypads	ON	CHARACTER ECHOING SELECTOR ON = ECHO ON OFF = ECHO OFF	OFF	OFF	OFF	OFF	ON	BAUD RATE SELECTOR OFF=9600 BAUD ON=1200 BAUD	✓Keypad ✓Encoder , configuration switch set ✓Panel Fixing prepared ✓+5V regulated supply ✓RS 232 cable with 6 way Molex socket ✓Ribbon cable keypad to encoder if needed ✓LCD and 16 way ribbon cable if needed ✓Polarising pins fitted to encoder

12 Way Telephone Layout Keypad   16 Way Telephone Layout Keypad

12 / 16 WAY KEYPAD CONTACT CONNECTIONS (REAR VIEW)

PINS	• • • • • • • •
PIN NUMBER	8 7 6 5 4 3 2 1

CONTACT MATRIX

PIN	ROW / COLUMN
1	R1
2	R2
3	C1
4	C2
5	C3
6	C4 (16 WAY ONLY)
7	R4
8	R3

12 / 16 WAY KEYPAD CONTACT CONNECTIONS (REAR VIEW)

PINS	• • • • • • • • • •
PIN NUMBER	10 9 8 7 6 5 4 3 2 1

CONTACT MATRIX

PIN	ROW / COLUMN
1	LED POWER
2	R1
3	R2
4	C1
5	C2
6	C3
7	C4 (16 WAY ONLY)
8	R4
9	R3
10	LED POWER

ASCII Codes

ROW/ COLUMN	C1	C2	C3	C4
R1	31	32	33	61
R2	34	35	36	62
R3	37	38	39	63
R4	2A	30	23	2E

Appendix 2. Configuration Switch Options - Keytop Legends / ASCII Codes

Configuration Switch Settings	1	2	3	4	5	6	7	8	Installation Checklist
12 and 16 Way Calculator Layout Keypads	ON	CHARACTER ECHOING SELECTOR ON = ECHO ON OFF = ECHO OFF	OFF	ON	OFF	OFF	ON	BAUD RATE SELECTOR OFF=9600 BAUD ON=1200 BAUD	✓Keypad ✓Encoder , configuration switch set ✓Panel Fixing prepared ✓+5V regulated supply ✓RS 232 cable with 6 way Molex socket ✓Ribbon cable keypad to encoder if needed ✓LCD and 16 way ribbon cable if needed ✓Polarising pins fitted to encoder

12 Way Calculator Layout Keypad   *16 Way Calculator Layout Keypad*
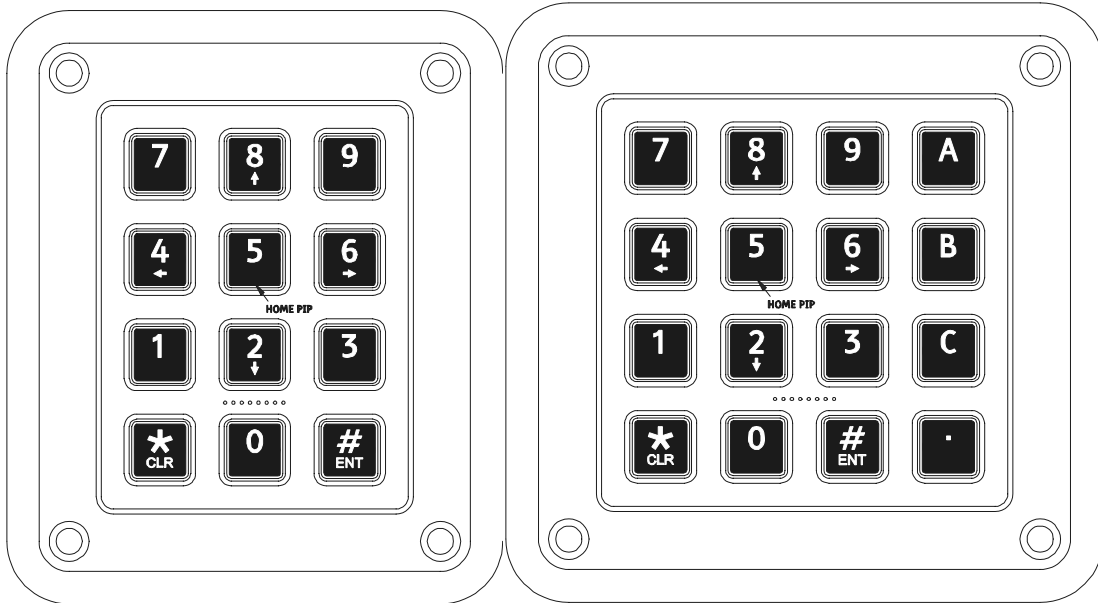
12 / 16 WAY KEYPAD CONTACT CONNECTIONS (REAR VIEW)

PINS	• • • • • • • •
PIN NUMBER	8 7 6 5 4 3 2 1

12 / 16 WAY KEYPAD CONTACT CONNECTIONS (REAR VIEW)

PINS	• • • • • • • • • •
PIN NUMBER	10 9 8 7 6 5 4 3 2 1

CONTACT MATRIX

PIN	ROW / COLUMN
1	R1
2	R2
3	C1
4	C2
5	C3
6	C4 (16 WAY ONLY)
7	R4
8	R3

CONTACT MATRIX

PIN	ROW / COLUMN
1	LED POWER
2	R1
3	R2
4	C1
5	C2
6	C3
7	C4 (16 WAY ONLY)
8	R4
9	R3
10	LED POWER

ASCII Codes

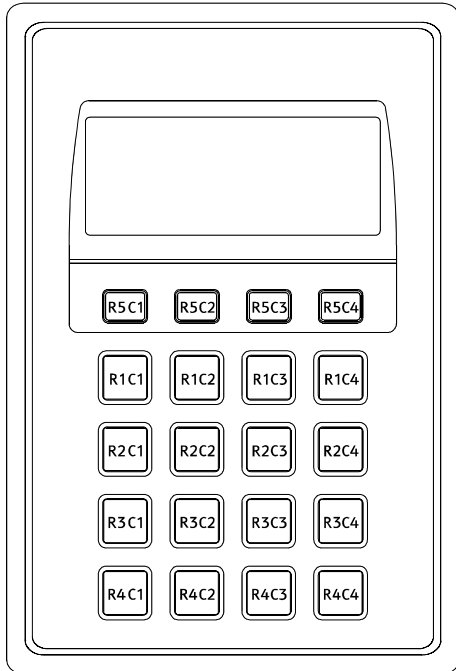| ROW/ COLUMN	C1	C2	C3	C4
R1	37	38	39	1B
R2	34	35	36	0C*
R3	31	35	33	05
R4	7F	30	0D	2E

* = Form Feed Code to give CLEAR function

Appendix 2. Configuration Switch Options - Keytop Legends / ASCII Codes

Configuration Switch Settings	1	2	3	4	5	6	7	8
Integrated 20 Way Keypad and Display - Telephone Layout	OFF	CHARACTER ECHOING SELECTOR	ON	OFF	OFF	ON	OFF	BAUD RATE SELECTOR
Integrated 20 Way Keypad and Display - Calculator Layout	OFF		ON	ON	ON	ON	OFF	
Note : Remove Jumpers from JP3 and JP4 in this configuration.		ON = ECHO ON OFF = ECHO OFF						OFF=9600 BAUD ON=1200 BAUD

Installation Checklist

✓Integrated 20 way Keypad
✓Encoder , configuration switch set
✓LCD and 16 way ribbon cable if needed
✓Panel Fixing prepared
✓+5V regulated supply
✓RS 232 cable with 6 way Molex KK socket
✓13 way ribbon cable keypad to encoder if needed
✓Polarising pins fitted to encoder

ROW / COLUMN DESIGNATIONS
(KEYPAD FRONT VIEW)
For Example R1C2 = Row 1 Column 2.   NB : A 20 way keypad is treated as 4 way + 16 way.

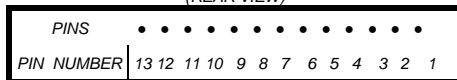### PIN-OUT FOR 20 WAY KEYPAD

20 WAY KEYPAD CONTACT CONNECTIONS (REAR VIEW)

PINS	• • • • • • • • • • • • •
PIN NUMBER	13 12 11 10 9 8 7 6 5 4 3 2 1

CONTACT MATRIX

PIN	ROW / COLUMN
1	NOT USED
2	TAMPER IN
3	R1
4	R2
5	C1
6	C2
7	C3
8	C4
9	R4
10	R3
11	R5
12	TAMPER OUT
13	NOT USED

ASCII CODE TABLES

Row / Column	Telephone Layout		Calculator Layout	
	Character	ASCII	Character	ASCII
R5C1	▲	11	▲	11
R5C2	▲	12	▲	12
R5C3	▲	13	▲	13
R5C4	▲	14	▲	14
R1C1	1	31	1	31
R1C2	2 ABC	32	2	32
R1C3	3 DEF	33	3	33
R1C4	A	41	ENTER	1B
R2C1	4 GHI	34	4	34
R2C2	5 JKL	35	5	35
R2C3	6 MNO	36	6	36
R2C4	B	42	CLEAR	0C
R3C1	7 PQRS	37	7	37
R3C2	8 TUV	38	8	38
R3C3	9 WXYZ	39	9	39
R3C4	C	43	?	05
R4C1	* CLR	2A	*	7F
R4C2	0	30	0	30
R4C3	# ENT	23	#	0D
.	ENTER	2E	CANCEL	2E
ANTI-TAMPER OPEN CIRCUIT		07*		07*
	* = CODE REPEATS EVERY 10 SECONDS WHILST CONDITION REMAINS ACTIVE			

Appendix 2. Configuration Switch Options - Keytop Legends / ASCII Codes

Configuration Switch Settings	R3	1	2	3	4	5	6	7	8	Installation Checklist
6000 Series Pinpad - Basic Layout	fitted	OFF	CHARACTER ECHOING SELECTOR	ON	OFF	ON	OFF	OFF	BAUD RATE SELECTOR	✓Keypad
6000 Series Pinpad - UK Layout	Remove before use	OFF		ON	OFF	ON	OFF	OFF		✓Encoder , configuration switch set ✓Panel Fixing prepared
6000 Series Pinpad - USA Layout	Remove before use	OFF	ON = ECHO ON	ON	ON	ON	OFF	OFF	OFF=9600 BAUD	✓+5V regulated supply ✓RS 232 cable with 6 way Molex KK socket
Note : R3 may need to be removed depending on the configuration required.			OFF = ECHO OFF						ON=1200 BAUD	✓13 way ribbon cable keypad to encoder if needed ✓Polarising pins fitted to encoder

BASIC LAYOUT

UK LAYOUT
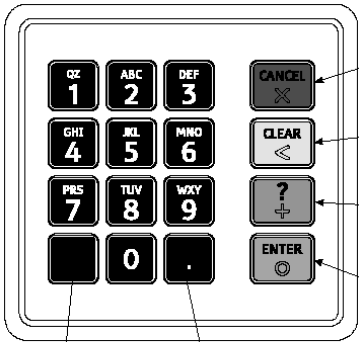
USA LAYOUT

BLANK KEY
No Key Code with
Standard Firmware

Key Code = Decimal Point
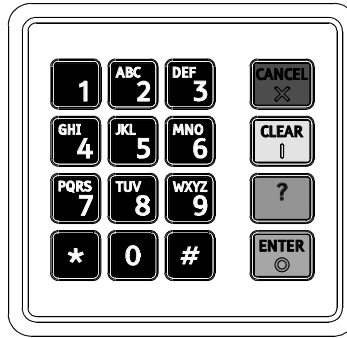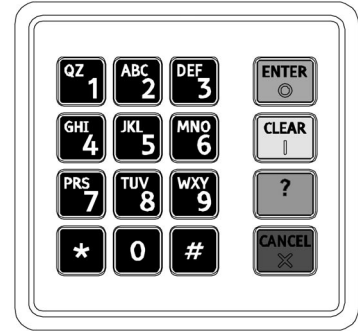
ROW / COLUMN DESIGNATIONS
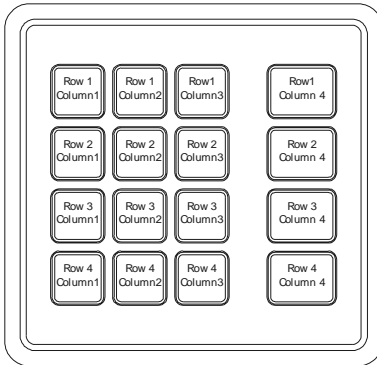
MATRIX WAY KEYPAD
CONTACT CONNECTIONS
(REAR VIEW)

PINS	• • • • • • • • • •
PIN NUMBER	10 9 8 7 6 5 4 3 2 1
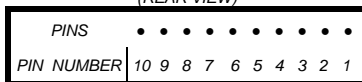
CONTACT MATRIX

PIN	ROW / COLUMN
1	TAMP
2	R1
3	R2
4	C1
5	C2
6	C3
7	C4
8	R4
9	R3
10	TAMP

ASCII CODE TABLES

Row / Column	Basic Layout			UK Layout			USA Layout		
	Marking	Base Key	ASCII	Marking	Base Key	ASCII	Marking	Base Key	ASCII
R1C1	1 QZ	Black	31	1	Black	31	1 QZ	Black	31
R1C2	2 ABC	Black	32	2 ABC	Black	32	2 ABC	Black	32
R1C3	3 DEF	Black	33	3 DEF	Black	33	3 DEF	Black	33
R1C4	CANCEL	Red with raised Cross	0D	CANCEL	Red with raised Cross	0D	ENTER	Green with raised circle	1B
R2C1	4 GHI	Black	34	4 GHI	Black	34	4 GHI	Black	34
R2C2	5 JKL	Black with Homepip	35	5 JKL	Black with Homepip	35	5 JKL	Black with Homepip	35
R2C3	6 MNO	Black	36	6 MNO	Black	36	6 MNO	Black	36
R2C4	CLEAR	Yellow with raised vertical line	7F	CLEAR	Yellow with raised vertical line	7F	CLEAR	Yellow with raised vertical line	7F
R3C1	7 PRS	Black	37	7 PQRS	Black	37	7 PRS	Black	37
R3C2	8 TUV	Black	38	8 TUV	Black	38	8 TUV	Black	38
R3C3	9 WXY	Black	39	9 WXYZ	Black	39	9 WXY	Black	39
R3C4	?	Blue with raised Plus	05	?	Blue	05	?	Blue	05
R4C1		Black	No Code	*	Black	2A	*	Black	2A
R4C2	0	Black	30	0	Black	30	0	Black	30
R4C3	.	Black	2E	#	Black	23	#	Black	23
R4C4	ENTER	Green with raised circle	1B	ENTER	Green with raised circle	1B	CANCEL	Red with raised Cross	0D
ANTI-TAMPER OPEN CIRCUIT			07*			07*			07*
*= CODE REPEATS EVERY 10 SECONDS WHILST CONDITION REMAINS ACTIVE. TO RESET—DISCONNECT POWER FOR 30 SECONDS.									

Appendix 3. LCD Character Map PC 2004LRU Display