IS-232/CC

USERS MANaul

THI S MANUAL APPLIES TO THE FOLLOWING PRODUCTS:

<table>
<thead>
<tr>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>10182</td>
</tr>
<tr>
<td>10181</td>
</tr>
</tbody>
</table>

REV | DESCRIPTION | APPR'VD | DATE |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
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PARTS LI STS
Interface Standards

Model IS-232/CC is a two wide microprocessor based CAMAC crate controller that interfaces to a host computer through an RS-232 serial asynchronous port. It supports RS-232 data rates between 110 and 19,200 baud.

Command and data transfer between the host and the IS-232/CC is in the form of strings of ASCII characters, totally independent of the host computer type. This means that no special driver software is required to access CAMAC. Standard FORTRAN formatted I/O or similar high-level language constructs are all that is necessary to control all aspects of CAMAC dataway operation. The IS-232/CC is thus a truly universal CAMAC interface.

The IS-232/CC can also be controlled directly by any conventional CRT or printing ASCII terminal. This allows direct interactive communication with the dataway for system checkout and troubleshooting. The IS-232/CC is available in Master or Auxiliary crate, controller versions.
CHAPTER 2

2. CONFIGURATION AND INSTALLATION

2.1 RS-232 CONNECTOR

Connection to a terminal or host computer is through a front panel 25-pin connector type DB-25P. The mating connector is type DB-25S. Figure 2-1 gives the pin out of the connector.

The CTS (pin 4) input can be used to regulate serial output from the IS-232/CC in accordance with standard RS-232 protocol.

If the CTS and RTS signals are not used, pins 4 and 5 must be jumpered together.

2.2 BAUD RATE SELECTION

This IS-232/CC supports all standard baud rates between 150 and 19200. The baud rate is selected by jumper near chip 23 (the 8251) of the CPU board as shown in Figure 2-2 (see also assembly drawing 10184). The standard setting is 9600 baud. To change it, remove the existing jumper and connect a jumper between the pad labelled "1" and the pad labelled with the desired baud rate.

2.3 FRONT PANEL

In addition to the RS-232 connector, the IS-232/CC has a reset switch on the front panel. Pressing this switch sets the controller to its initial state and executes a Z cycle on the dataway. The upper position of the reset switch has no effect.

2.4 AUXILIARY INSTALLATION

The IS-232/CC/ A operates as an auxiliary crate controller in accordance with ANSI/IEEE Std 675-1982. It will work with any master crate controller that supports the Auxiliary Controller Bus (ACB).

As an auxiliary, the IS-232/K/A plugs into any pair of crate slots except 24 and 25. Connect a 40-wire flat cable from the right angle pin connector (not the card edge connector) at the rear of the unit to the corresponding connector on the master crate controller.
The IS-232/CC/A utilizes the "Request/Grant" protocol as described in IEEE Std. 675-1982. This requires that the 61 (Grant In) LEMO connector on the front panel be connected either to the REQ (Request) connector, if the IS-232/CC is to have the highest priority, or to the Grant Out connector of a higher priority controller. Likewise, Grant In of a lower priority controller connects to the 60 connector of the IS-232/CC/A.

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>Transmit Data *</td>
</tr>
<tr>
<td>3</td>
<td>Receive Data *</td>
</tr>
<tr>
<td>4</td>
<td>Clear to Send (CTS)</td>
</tr>
<tr>
<td>5</td>
<td>Request to Send (RTS)</td>
</tr>
<tr>
<td>6</td>
<td>Data Terminal Ready (DTR)</td>
</tr>
<tr>
<td>7</td>
<td>Ground</td>
</tr>
<tr>
<td>20</td>
<td>Data Set Ready (DSR)</td>
</tr>
</tbody>
</table>

*with respect to IS-232/CC

Figure 2-1 RS-232 Connector Pinout
Figure 2-2 Baud Rate Jumper
This section gives you all the information you need to program the IS-232/CC.

### 3.1 COMMAND FORMAT

A command to the IS-232/CC consists of a string of ASCII text characters received through the RS-232 serial port. This string must be terminated by a carriage return character.

The command string is broken down into a sequence of alphanumeric "tokens" consisting of a single "token-identifier" character which may be followed by one or two numeric parameters. All parameters are decimal except for the W token which accepts octal, decimal or hexadecimal parameters (see section 3.3.1). Non alphanumeric delimiters such as space, may be inserted anywhere in the line (except in the middle of a parameter) to improve readability. The appendix shows the format of a command line in terms of formal syntax diagrams.

Execution does not occur until the carriage return character is received. Then the tokens are executed one at a time in the order received.

In fact, a command need not contain any tokens, that is it may consist of only the carriage return. This is a command to repeat the most recently executed dataway cycle (see section 3.2.2).

### 3.2 TOKENS

The set of recognized token identifiers breaks down into two basic categories: 1) Dataway parameter tokens and 2) Mode control tokens.

#### 3.2.1 Dataway Parameter Tokens

Table 3-1 lists the dataway parameter tokens along with the permissible range of their parameters and the initial value on power up or on reset. Most of these tokens represent the standard dataway parameters and operations, i.e., N, A, F, Z, C, and I.
The "W" token supplies data for dataway write operations. This is the only token which accepts more than one parameter. If only one parameter follows the W, it is applied to the low order 16 dataway W lines, that is W1 to W16. W17 to W24 are not changed. If two parameters follow the W, the first is applied to W17 to W24 and the second is applied to W to W6.

The "Z" and "C" tokens cause the crate controller to execute respectively, dataway initialize (Z) and dataway clear (C) cycles. The "I" token controls the dataway inhibit line. IO clears dataway inhibit while II sets it.

The "R" token allows a dataway cycle to be repeated a specified number of times. This is particularly useful when reading out modules which contain a large amount of data such as transient digitizers. During dataway execution the repeat count is decremented before it is tested for 0. This means that an initial repeat count of 0 is equivalent to 65,536 dataway cycles. The repeat count does not apply to the Z or C tokens. They are executed once each time they are encountered.

The "D" token controls the spontaneous generation of messages in response to crate LAMs. D1 enables spontaneous LAM message generation while D0 disables it. The message consists of an "L" token containing the station number of the highest priority pending LAM. Priority is directly proportional to station number. LAM message generation is automatically disabled when a LAM occurs. Therefore the LAM service routine should include a D1 token.

While spontaneous LAM messages are disabled, you can test for the presence of LAMs with the "T" token. This causes the crate controller to respond with an "L" token. If no LAM is pending, the token value is 0.

### 3.2.2 Current Dataway Command Register

The IS-232/CC program maintains a "Current Dataway Command Register" (CDCR) holding the most recent values of the N, A, F, W, and R tokens. Whenever any one of these tokens is received, the corresponding element of the CDCR is updated. When the carriage return is detected, the current contents of the CDCR is executed.
When executing a series of dataway commands, you need only send the tokens which actually change in value.

Example:

```
N15 A0 F17 W8 <cr> :F(17) at N(15) A(0) Data 8
N16 <cr> :F(17) at N(16) A(0) Data 8
F16 W400 AI <cr> :F(16) at N(16) A(1) Data 400
F25 <cr> :F(25) at N(16) A(1)
<cr> :Do it again
```

Note that a "null command, that is a command with no tokens, simply repeats the last dataway cycle(s).

A "non-null" command which does not change any values in the CDCR does not cause dataway execution (except for Z and C which are "special" anyway).

3.2.3 Mode Control Tokens

The tokens listed in Table 3-2 control the operating mode of the IS-232/CC. Operating mode encompasses such things as: size and base of data parameters, whether the controller is connected to a terminal or a computer, etc. The remainder of this chapter describes the various elements of mode control.

3.3 DATA FORMAT

3.3.1 Base

The IS-232/CC can handle data in Octal, Decimal or Hexadecimal as selected by the B (for Base) token. The parameter attached to the B token determines the base for all subsequent data transfers as follows:

1 - Octal - Initial Value
2 - Hexadecimal
3 - Decimal

Note that this only affects W parameters and the response of the controller to a read dataway cycle. All other token parameters are always decimal.
3.3.2 Size

The S token lets you specify how much data the IS-232/CC returns in response to a read dataway cycle. The parameter attached to the S token specifies the number of bytes of read data returned by the controller. The range is 1 to 3 with an initial value of 3.

In this context, the term "bytes" actually refers to the range of values returned rather than the length of the response. Thus a read command executed while S1 is in effect will only return values in the range of 0 to 255 representing the lower eight dataway R lines. S2 allows values in the range of 0 to 65,535. S3 causes a read command to return two numbers separated by a comma. The first number has a range of 0 to 255 representing R17 to R24. The second number represents R1 to R16 with a range of 0 to 65535. See section 3.5.1 for more details on the controller's response.

3.4 OPERATING MODE

Operating mode is a function of whether the IS-232/CC is connected to a terminal or to a computer. Two tokens control operating mode: M for mode and E for echo.

3.4.1 Terminal Mode

M1 specifies "terminal mode" meaning the IS-232/CC is being controlled by a terminal. In this mode, the controller issues an asterisk prompt to tell the operator that it is ready to accept a command. It also echoes all characters that it receives and follows a carriage return character with a line feed.

Certain ASCII codes are interpreted in accordance with common practice for editing and terminal control purposes. DEL (also called Rubout) deletes the most recently entered character and backspaces the cursor on the terminal.

3.4.2 Computer Mode

M0 sets the IS-232/CC in "Computer Mode" whereby the crate controller is made to look like a terminal to a host computer. The crate controller does not echo received characters, does not send linefeed following carriage return and does not issue a prompt. Otherwise computer mode operation is essentially identical to Terminal mode.
Most computers echo characters received from terminals. The protocol of the IS-232/CC is designed so that echoed text is distinguishable from command text so that the former can be ignored by the controller.

The controller assumes computer mode on reset. If you are controlling the IS-232/CC from a terminal, you will not see any response to power up or reset. The first command you should enter is E1 <cr>, Then M1 <cr>. Note that this command will not be echoed but it will bring up the asterisk prompt.

3.4.3 Wait For Echo

The E token is another way of regulating the rate of data transfer between the crate controller and a computer. In "Echo Mode" (EO, the reset state), the controller sends a character and then waits for that character to be echoed by the computer before sending the next character. This gives the computer a simple way of regulating data transfer by just not echoing a character until it is ready to accept the next one. The disadvantage is that it reduces throughput by a factor of two.

In "Non-echo mode", E1, the controller simply sends data at maximum rate, subject of course to the DTR signal.

3.5 CONTROLLER RESPONSE

3.5.1 Dataway Cycle

The controller's response to executing a dataway cycle may vary from nothing up to three integer numbers separated by commas. This is a function of the Q and S tokens and whether or not the dataway cycle was a read command. The full controller response can be represented syntactically as follows:

\[
\text{Dataway Response : } = [DQX] [, Hi data], Lodata <cr>
\]

\(DQX\) represents dataway Q and X encoded in a single digit as follows:

<table>
<thead>
<tr>
<th>Value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>X=1, Q=1</td>
</tr>
<tr>
<td>1</td>
<td>X=1, Q=0</td>
</tr>
<tr>
<td>2</td>
<td>X=0, Q=1</td>
</tr>
<tr>
<td>3</td>
<td>X=0, Q=0</td>
</tr>
</tbody>
</table>

Thus a value of 0 represents a "normal" cycle.
Hidata and Lodata are returned only for read cycles. Hidata represents dataway R17 to R24 with a range of 0 to 255 and Lodata represents R1 to R16 with a range of 0 to 65535. Data may be returned in octal, decimal or hex as selected by the B token (see section 2.2.1). In all cases leading zeros are suppressed so that data is represented in the smallest number of characters.

The Q token determines whether or not DQX is sent. Q1 (the power up state) sends DQX and Q0 suppresses it. Independent of the state of the Q token, DQX is always sent in response to a F(8) or F(27) dataway cycle.

The S token regulates the amount of data sent in response to a read dataway cycle. The values of S and their meaning are as follows:

<table>
<thead>
<tr>
<th>S</th>
<th>Dataway</th>
<th>Hidata</th>
<th>Lodata</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>R1 - R</td>
<td>*</td>
<td>0 to 255</td>
</tr>
<tr>
<td>2</td>
<td>R1 - R16</td>
<td>*</td>
<td>0 to 65535</td>
</tr>
<tr>
<td>3</td>
<td>R1 - R24</td>
<td>0 to 255</td>
<td>0 to 65535</td>
</tr>
</tbody>
</table>

*Hidata is not sent for S1 or S2*

Note the range of Lodata. Many high level languages running on 16-bit computer restrict integers to a range of -32768 to +32767. Thus a response from the 1S-232/CC in the range of 32768 to 65535 would be flagged as an error. If you expect data in this range, you should read it in octal or hexadecimal since most systems treat such numbers as unsigned integers with a range of 0 to the word size of the computer.

3.5.2 LAM

In response to a T token, or if a LAM occurs while interrupts are enabled (DI), the controller sends

Lnn <cr>

Where nn is the station number of the highest priority pending LAM. If the LAM message is in response to a T token and no LAM is pending, nn = 0.

3.6 ERROR DETECTION AND RECOVERY

Errors can occur either because an operator enters the wrong data when running in terminal mode or because noise corrupts a message from a host.
computer. The IS-232/CC has provisions for detecting certain errors and recovering from them in cooperation with the terminal operator or host computer.

3.6.1 Errors Detected by the Controller

The controller can detect three types of errors in messages sent to it:

1. Illegal token. i.e. "J"
2. Value out of range. i.e. "N43"
3. Non-numeric parameter. i.e. "W1#37"

In response to a detected error, the controller returns the erroneous token preceded by a question mark "?". Example:

?N43 <cr>

All previous tokens in the same command line are acted upon. All tokens following are ignored and no dataway cycles are executed.

Note that simple FORTRAN formatted numeric input statements cannot properly cope with this type of response since it involves nonnumeric characters (the same thing applies to the L token). Therefore you should test for a question mark in the first character before attempting to decode the response as integers. The subroutine example in section 4 shows one way of handling this.

3.6.2 Errors Detected by the Host Computer

Electrical noise may cause the controller's response to be garbled. This usually results in an illegal character being detected by a formatted input statement. The host computer may then send a V token (for verify) to have the controller repeat its most recent reply. The subroutine example in section 4 shows a way of handling this.

3.6.3 Reinitializing

It may happen that the controller and host computer get "out of sync" with each other. This is particularly likely in the process of debugging the host software.
The K token reinitializes the IS-232/CC back to its power-on state. This token is executed immediately, as soon as it is received, without waiting for a carriage return. Any tokens preceding it in the command are ignored (since they are waiting for a carriage return). Any tokens following it will be executed.
<table>
<thead>
<tr>
<th>TOKEN</th>
<th>NUMERIC DATA</th>
<th>INITIAL STATE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1 TO 23</td>
<td>1</td>
<td>SET STATION NUMBER</td>
</tr>
<tr>
<td>A</td>
<td>0 TO 15</td>
<td>0</td>
<td>SET SUBADDRESS</td>
</tr>
<tr>
<td>F</td>
<td>0 TO 31</td>
<td>0</td>
<td>SET FUNCTION CODE</td>
</tr>
<tr>
<td>W</td>
<td>UP TO 24 BITS</td>
<td>0</td>
<td>WRITE DATA</td>
</tr>
<tr>
<td>Z</td>
<td>NONE</td>
<td>-</td>
<td>EXECUTE DATAWAY INITIALIZE</td>
</tr>
<tr>
<td>C</td>
<td>NONE</td>
<td>-</td>
<td>EXECUTE DATAWAY CLEAR</td>
</tr>
<tr>
<td>I</td>
<td>0 OR 1</td>
<td>1</td>
<td>CLEAR/SET DATAWAY INHIBIT</td>
</tr>
<tr>
<td>R</td>
<td>0 TO 65,535</td>
<td>1</td>
<td>REPEAT COUNT</td>
</tr>
<tr>
<td>D</td>
<td>1 OR 0</td>
<td>0</td>
<td>ENABLE/DISABLE LAMs</td>
</tr>
<tr>
<td>T</td>
<td>NONE</td>
<td>-</td>
<td>TEST FOR LAM PENDING</td>
</tr>
</tbody>
</table>

Table 3-1: Dataway Tokens

<table>
<thead>
<tr>
<th>TOKEN</th>
<th>NUMERIC DATA</th>
<th>INITIAL STATE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>0 OR 1</td>
<td>0</td>
<td>Q, X STATUS BIT REPORTING</td>
</tr>
<tr>
<td>S</td>
<td>1, 2 OR 3</td>
<td>3</td>
<td>SET READ DATA SIZE 8, 16, OR 24 BITS</td>
</tr>
<tr>
<td>B</td>
<td>1, 2 OR 3</td>
<td>1</td>
<td>SET DATA MODE 1=OCTAL, 2=HEX, 3=DECIMAL</td>
</tr>
<tr>
<td>M</td>
<td>1 OR 0</td>
<td>0</td>
<td>SET OPERATING MODE 1=TERMINAL 0=COMPUTER</td>
</tr>
<tr>
<td>E</td>
<td>1-OR 0</td>
<td>0</td>
<td>SET ECHO MODE 0=WAIT FOR ECHOED CHARACTER</td>
</tr>
<tr>
<td>V</td>
<td>NONE</td>
<td></td>
<td>RESEND LAST REPLY</td>
</tr>
</tbody>
</table>

Table 3-2: Mode Control Tokens
SUBROUTINE CAM232(C,N,A,F,HDATA,LDATA,Q)

THIS IS AN EXAMPLE OF ACCESSING THE IS-232/CC CRATE CONTROLLER
DIRECTLY FROM HIGH-LEVEL LANGUAGE. IT IS BY NO MEANS AN OPTI-
MAL SOLUTION BUT IS INTENDED AS AN EXAMPLE.

C, REPRESENTING A CAMAC CRATE NUMBER, IS INTERPRETED AS A FORTRAN
LOGICAL I/O CHANNEL TO WHICH THE IS-232/CC IS CONNECTED. THIS
MUST HAVE BEEN PREVIOUSLY OPENED BY A FORTRAN "OPEN" STATEMENT.
N, A AND F ARE INPUT PARAMETERS REPRESENTING THE CORRESPONDING
CAMAC ENTITIES. HDATA AND LDATA ARE BIDIRECTIONAL PARAMETERS
WHICH SUPPLY DATA TO DATAWAY WRITE CYCLES AND ACCEPT DATA FROM
DATAWAY_READ_CYCLES. Q REFLECTS THE VALUE OF DATAWAY Q. IT RE-
TURNS .TRUE. IF Q = 1 AND .FALSE. IF Q = 0.

CAM232 MAINTAINS ITS OWN COPY OF THE "CURRENT DATAWAY COMMAND"
REGISTER (CDCR) MAINTAINED BY THE IS-232/CC FIRMWARE. THIS IS
BASED ON THE NOTION THAT IT IS FASTER TO DETERMINE IF A PARAMETER
NEEDS TO BE SENT THAN TO SEND IT IF IT DOESN'T NEED TO BE SENT.

CAM232 READS THE CONTROLLER'S RESPONSE AS AN ASCII TEXT STRING WITH
OUT FORMATTING SO AS TO PROPERLY DETECT AN ERROR RESPONSE FROM THE
CONTROLLER. A NON-ERROR RESPONSE IS THEN DECODED TO GENERATE THE
APPROPRIATE VALUES.

THIS ROUTINE HAS BEEN COMPILED AND EXECUTED UNDER DIGITAL EQUIP-
MENT CORPORATION'S RT-11 VERSION 4.0

BYTE C,N,A,F,Q,STATUS,EFLAG
BYTE NCUR,ACUR,FCUR,HCUR,STRING(30)
INTEGER LDATA,HDATA !ASSUMES 16_BIT_INTEGER_REPRESENTATION
COMMON STRING
DATA NCUR,ACUR,FCUR,HCUR /1,0,0,0/ !INITIAL VALUES IN IS-232/CC

100 EFLAG = .FALSE.
STRING(1) = '/'
STRING(2) = '}' ' ' !SINGLE APOSTROPHE
STRING(3) = ' 'I = 4
IF (N .EQ. NCUR) GO TO 110
ENCODE (3,1000,STRING(I)) 'N',N
I = I + 3

110 IF (A .EQ. ACUR) GO TO 120
ENCODE (3,1000,STRING(I)) 'A',A
I = I + 3

120 IF (F .EQ. FCUR) GO TO 130
ENCODE (3,1000,STRING(I)) 'F',F
I = I + 3

130 IF ((F.LT.16) .OR. (F.GT.23)) GO TO 180

180
0026 IF (HDATA .EQ. HCUR) GO TO 160
0028 ENCODE (10, 1001, STRING(I)) HDATA, LDATA
0029 I = I + 10
0030 GO TO 180

C
0031 160 ENCODE (7, 1002, STRING(I)) LDATA
C
C EXECUTE AND READ THE RESULTS
C
0032 180 STRING(I) = '    '
0033 STRING(I+1) = '
0034 190 WRITE (C, STRING)
0035 Q = .FALSE.

C
0036 THIS FOOLISHNESS IS REQUIRED BY THE PECULIAR NATURE OF FORTRAN
C FORMATTED I/O
0037 200 READ (C, 1003)
0038 ENCODE (15, 1003, STRING)

C
0039 IF (STRING(I) .EQ. '?') GO TO 190 ! CONTROLLER DETECTED AN ERROR TRY AGAIN

C
0040 UPDATE LOCAL CURRENT DATAWAY COMMAND REGISTER
0040 NCUR = N
0041 ACUR = A
0042 FCUR = F
0043 HCUR = HDATA

C
0044 IF (F .LT. 8) GO TO 220
0045 DECODE (15, 1004, STRING, ERR=500) STATUS ! NON-READ FUNCTION
0046 GO TO 300

C
0048 MORE FOOLISHNESS
0048 220 DO 240 I=6, 15 ' READ_REPLY IS AT LEAST 5 CHARACTERS
0049 240 IF (STRING(I) .EQ. ' ') GO TO 260
0050 260 DECODE (I-1, 1005, STRING, ERR=500) STATUS, HDATA, LDATA

C
0052 300 IF (((STATUS.EQ.0) .OR. (STATUS.EQ.2)) Q = .TRUE.
0054 RETURN

C
0055 IF ERROR DETECTED, ASK IS-232/CC TO RESEND LAST REPLY
0056 500 IF (EFLAG) PAUSE ' UNRECOVERABLE ERROR FROM IS-232/CC'
0057 WRITE (C, 1006)
0058 EFLAG = .TRUE.
0059 GO TO 200 ! GO GET NEW REPLY

C
0060 1000 FORMAT (A1, I2)
0061 1001 FORMAT ('W', I3, I6) ! BOTH HDATA AND LDATA
0062 1002 FORMAT ('W', I6) ! LDATA ONLY
0063 1003 FORMAT (SHREPLY GOES HERE)
0064 1004 FORMAT (I1) ! STATUS ONLY RESPONSE
0065 1005 FORMAT (I2, I4, I6) ! READ DATA RESPONSE
0066 1006 FORMAT (' V') ! RESEND REPLY

C
0067 END
1. Only upper case alphabetic characters are recognized.

2. When initializing to terminal mode, the El token must precede the M token. Both tokens may be in one command line. The prompt will not appear until the first dataway cycle is executed. Typing carriage return at this point will execute N(I)A(O)F(O) and bring up the prompt.

3. A prompt will not appear after a command that does not execute a dataway cycle, i.e., contains only mode tokens or F, C or I. Nevertheless, the IS-232 is ready to accept a command and will display the prompt after the next dataway cycle.

4. The first parameter of the W token always goes to W17-W24 even if there is only one parameter.

5. In a command which contains Z or C together with one or more dataway tokens, the Z or C is executed before the dataway cycle regardless of the order of the tokens.
TYPE A TOKEN:

TYPE B TOKEN:

TYPE C TOKEN:

*Denotes legal range