HDice CAENels CT-BOX Current Measurement System Device Drivers

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A CAENels CT-BOX Current Measurement System is used in the Hall B HDice experiment nuclear magnetic resonance (NMR) system. A LabVIEW device driver library was developed to support the remote operation and readout of the CT-BOX system.

The CAENels CT-BOX was a new product without supporting software when purchased for HDice. The firmware was under development. Only a basic command set was available for the development of a LabVIEW device driver library, required to support the development of higher-level programs for CT-BOX specification testing and incorporation into the HDice NMR program.

The CT-BOX has three communication interfaces—RS232, USB, and Ethernet—all three having the same command structure. The commands to the CT-BOX are sent in ASCII format and are composed of a command field and parameter fields, separated by a colon.

Each instruction command must be terminated with a carriage return. Table I shows the syntax of the command to turn on the CT-BOX data acquisition. Upon receipt of the write command, the validity of the command is checked by the CT-BOX. If the command is valid, and executed without an error, the CT-BOX responds with an acknowledge (ACK\r\n). If the command received is invalid, or an error occurred during execution, the CT-BOX responds with a not acknowledge (NAK) as shown in Table I. Table II shows examples of critical error responses. There is a total of 75 possible code error responses.

ACQ:ON\r	NAK:2:1\r\n
ACQ - command field	NAK - not acknowledge response
: - parameter separation character	: - parameter separation character
ON - parameter field	2:1 - sample error code
\r - command termination character	\r\n - reply termination sequence

TABLE I. Syntax for data acquisition on command and command error response.

There are two types of commands, write (set) and read. A write command instructs the CT-BOX to perform a function for which no return data is expected, and the CT-BOX returns either an acknowledge or a not acknowledge. A read command will return data when it is executed and depending on the command, may or may not return an acknowledge. If an error occurs during a read command, the CT-BOX will always return a not acknowledge with the appropriate error code.

All commands to the CT-BOX are processed one at a time; therefore, the code must wait for a response from the unit before sending the next command.

| Error code	Error description
0:0	command syntax not valid
2:1	MODE parameter not valid
3:2	ACQ command not allowed during acquisition mode
5:1	FREQ parameter wrong
7:2	ALARM command not allowed during acquisition mode
7:4	ALARM limit parameter out of DCCT range
8:3	oscilloscope mode not supported with RS232
9:1	when high, current over limit
20:3	DCCT head not connected
25:2	ERR command not allowed during acquisition mode

TABLE II. Example of CT-BOX command error codes.
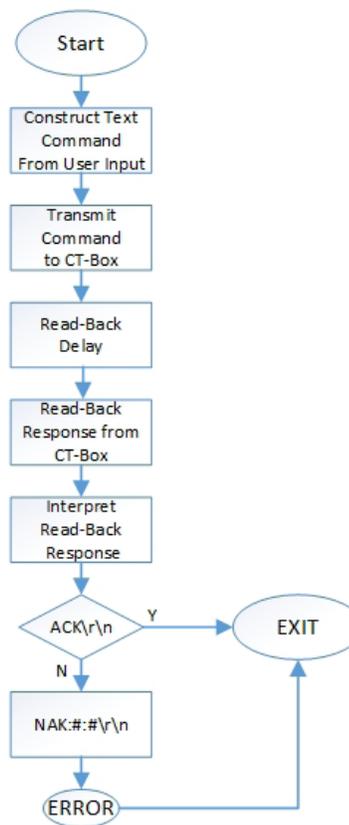
FIG. 3. Typical write command flowchart.
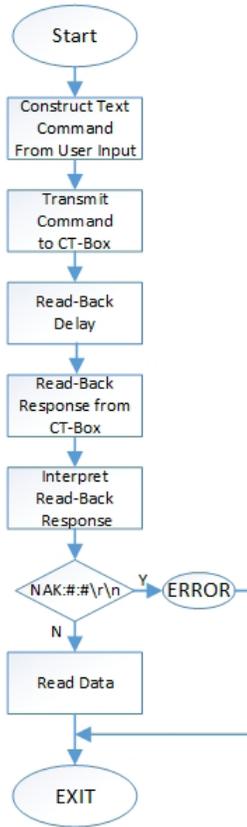
FIG. 4. Typical read command flowchart.

FIG. 5. DAQ command sequence flowchart.

Using the CT-BOX firmware command definitions, syntax, parameter, and termination requirements, along with the expected command responses, LabVIEW device drivers were written. Figures 3 and 4 show LabVIEW program flowcharts for the typical write and read commands respectively.

Figure 5 shows the unique write command to start acquiring data while in the oscilloscope mode (measurements up to 100 kHz). After the successful receipt and acknowledge of the acquire data command, the CT-BOX will transmit measurements continuously until the acquisition off (ACQ:OFF\r) command is issued.

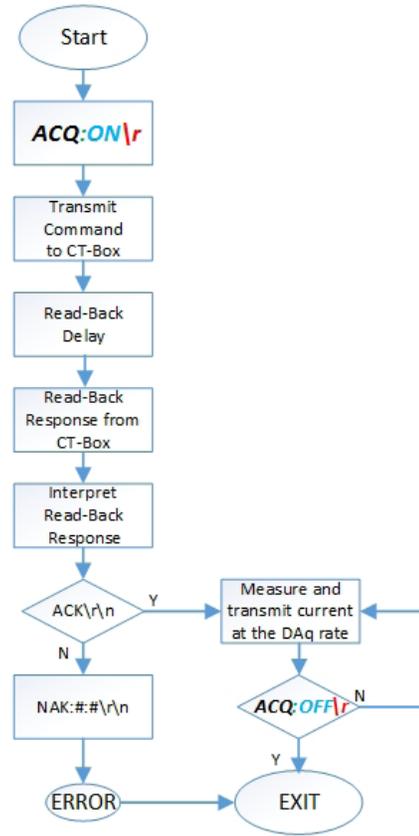Figure 6 shows the LabVIEW code and GUI developed to

support the setting of the acquisition frequency (Write FREQ. VI) in the datalogger mode (0.01 Hz–10 Hz). Figure 7 shows the code and GUI developed to support the reading of the CT-BOX internal status frequency (Read STATUS.VI).

In all, 55 LabVIEW device drivers were developed, tested, debugged, and implemented for the CT-BOX. Table III shows a sample of the 29 write and 26 read device drivers.

In conclusion, a LabVIEW device driver library has been developed, tested, debugged, and implemented for the CAENels CT-BOX Current Measurement System used in the Hall B HDice experiment.

| Type	Command syntax	Command description	Filename
write	FREQ:X.X\r	set sampling time in datalogger mode to X.X Hz	write FREQ.VI
write	OFFSET:ZERO\r	write zero offset (primary current must equal zero)	write OFFSET.VI
write	HWRESET:FORCE\r	force CT-BOX to remotely reset	write HWRESET.VI
write	MODE:XXX\r	write XXX mode; :OSC for oscilloscope, :DLOG for datalogger	write MODE.VI
write	ALARM:ON \r	turn on alarm functionality	write ALARM.VI
read	ERR:? \r	read CT-BOX error register	read ERR.V
read	STATUS:? \r	read CT-BOX status register	read STATUS.VI
read	TIME:? \r	read internal real-time clock	read TIME.VI
read	IP:? \r	read CT-BOX IP address	read IP.VI
read	TS:? \r	read time sampling interval in oscilloscope mode	read TS.VI

TABLE III. Sample of CT-BOX command device drivers.
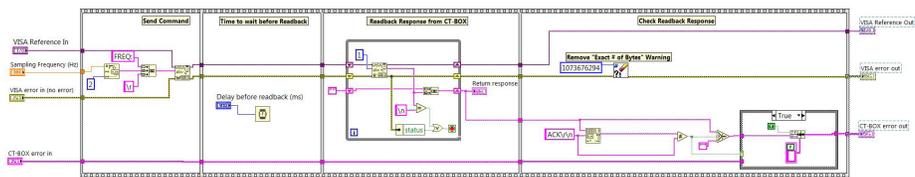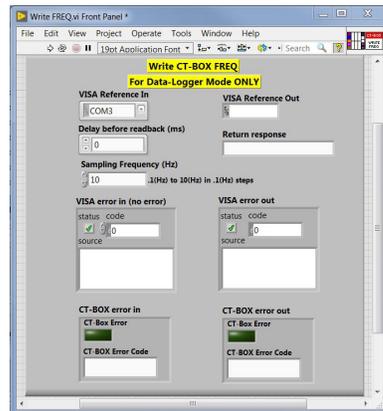
FIG. 6. (a) LabVIEW write frequency command code and (b) corresponding LabVIEW GUI.
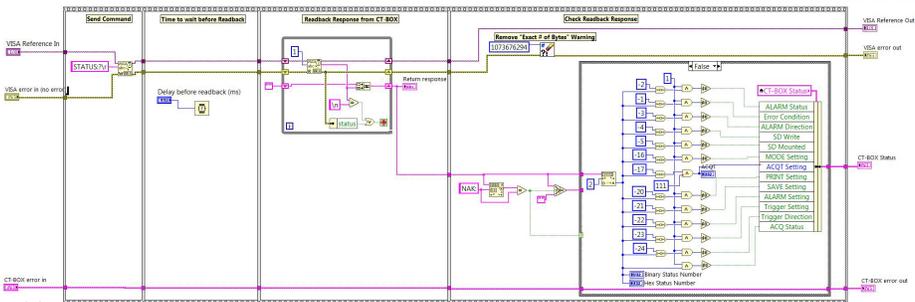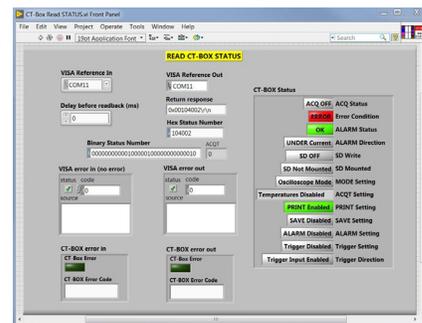
FIG. 7. (a) LabVIEW read status command code and (b) corresponding LabVIEW GUI.

3