

# B070

**Hawkeye DART Rack Controller**  
(previously known as V6081)



## User Guide

Provisional Version 0.4



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# Document history

**Date of first publication** 3<sup>rd</sup> Jan 2008

**Current issue and date** 0.4 / 3<sup>rd</sup> Jan 2008

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# Introduction

The B070 DART Rack Controller is a modified version of the V6081. It contains its own DARTnet interface and is designed for use with Hawkeye modules in V1606 3RU frames.

DARTnet is a proprietary protocol based on the versatile and highly rugged CAN 2.0B physical layer developed for the industrial and automotive market. It is used in this application to provide a control system that allows relatively simple control devices to manage a network of functional units. All the controlling devices and controlled frames, known colloquially as Nodes, are linked together by DARTnet as the physical layer. A separate, simpler communication protocol, DARTbus, which uses I<sup>2</sup>C as its physical layer, is used within the frame.

It has the advantage that the DARTnet load is determined by the total number of frames rather than individual modules which helps to reduce network size.

The B070 DART Rack Controller is the hardware module that interfaces between DARTnet (CAN) and DARTbus (I<sup>2</sup>C) in V1606 frames.

The B070 resides in its own dedicated slot above the power supplies in the V1606 frame and provides access for up to 14 DART compatible modules in each frame. It is identified by a unique address which must be set correctly for the whole installation.

## Advanced features

One advantage of using DARTnet is that the set-up data for modules in a frame are stored on the B070 and not individual modules. This means that if a module is changed with another of the same type it will automatically be set up with the same data, provided that a control network exists to manage module parameters.

Detailed status information is available via a local 3-digit 7-segment display and built in multi-level error-checking guards against data corruption.

There is also a safe guard in the form of *Swap Memory* against losing setup data if the wrong module is inserted in a slot.

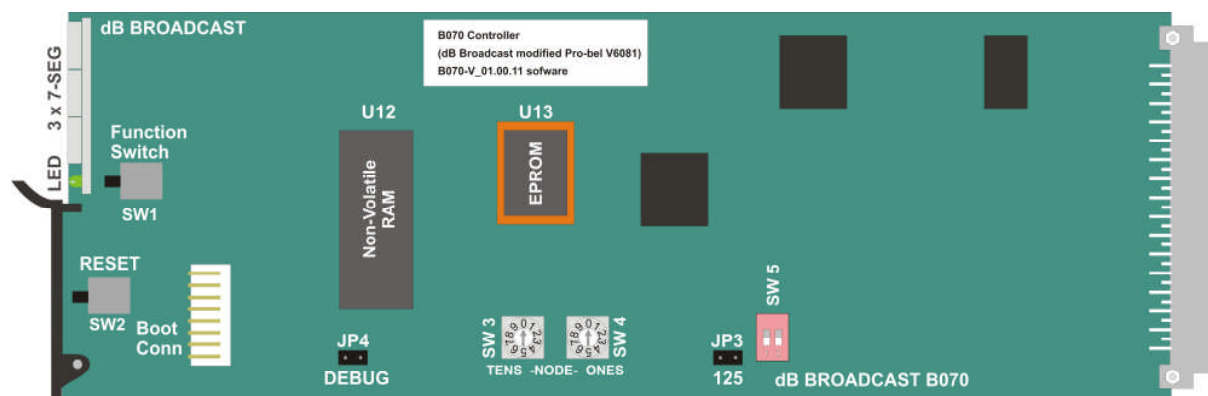
## Applications

The B070 is an essential part of control systems using B067 PC-GUI/SNMP remote control software. The B067 software works with the B065 interface to provide control of Hawkeye modules over RS232 and Ethernet. Third party vendors also supply solutions to control DART systems, such as Pro-Bel's ViewNET.

**Note:** In frames using the B065 controller, the B070 must be used with B070-V\_01.00.11 software.

# Installation

The B070 DART Rack Controller fits into a dedicated slot above the power supplies in the V1606 frame. The connection to DARTnet is via an RJ45 connector on the back of the frame.



## Power consumption

The B070 power consumption is 3.0W (at 15V input).

## Configuration

ITEM	Title	Comments
3-Digit 7-Segment Display	FRONT PANEL DISPLAY	Shows DART address, DARTnet activity and error flags. It can also display general status information in conjunction with SW1.
LED	POWER	Front panel Indication of PCB 5V rail.
SW1	FUNCTION SWITCH	Press momentarily to change what is displayed. Hold in for 5 seconds to reset NVRAM.
SW2	RESET SWITCH	Push to manually reset the Rack Controller.
BOOT CONN	BOOT CONNECTOR	Used in production to load boot loader program and by engineers for internal status information and logging.
JP4	DEBUG	This jumper must be left open.
U12	NVRAM	Non-volatile RAM holds frame's current status and control.
SW3/SW4	NODE ADDRESS	Used for setting the frame's DART Address.
U13	EPROM	Flash PROM used for upgrading the program in the microcontroller's Flash memory.
JP3	CAN SPEED	Linked to select 125 kbps instead of 250kbps. Leave unlinked – all systems work at 250kbps.
SW5	TEST SWITCH	Sets PCB into production test mode and enables debug functions. Leave both levers <b>DOWN</b> for normal operation.

## DART termination

DARTnet uses balanced two-wire communications and the network should be continuous, without stubs, and terminated with 120 Ohms. Larger DARTnet networks may require a termination at either end. The V1606 frame has a termination switch on its rear panel.

**Note:** DARTnet may only be used in some applications, such as the Hawkeye B067 PC-GUI to connect to a local Ethernet or RS232 interface (i.e. B065) for wider system control.

## Node address and CAN speed

The two rotary switches **SW3** and **SW4** set the DART address of the frame. This can be any number between 0010 and 6210 that isn't being used for any other frame or controller on the network. For more information, refer to [DART address setting](#) in the Operation chapter.

**Note:** Jumper JP3 is inserted to change the CAN bus speed from 250 kbps to 125 kbps for very large networks. For more detail refer to [DARTnet speed](#) in the Operation chapter.

**The lower speed is not normally used so JP3 should not be inserted.**

## Front panel display and function switch

The front panel display shows the DART address (i.e. **A23**), DARTnet activity and error flags.

It can also be used to display a range of status information by using function switch **SW1**, accessible through a hole in the display PCB.



Repeated operation of **SW1** toggles the display through a range of status information as shown in the table below.

Code	Description
Ann	DART address
Cxx	CANbus error flags
tnn	Frame temperature °C
Pnn	PSU voltage (bus)
Hxx	Heartbeat Op Mode
rnn	Main software revision
bnn	Boot loader revision
Fnn	FPGA revision

Note: xx = hex; nn = decimal.

The display reverts to the DART address after 30 seconds if SW1 is not pressed.

If **SW1** is pressed and held in for 5 seconds, the NVRAM is reset and the display changes momentarily to indicate that the reset is taking place.

rrr	NVRAM resetting
-----	-----------------

**TIP:** It is recommended to press **SW2**, after resetting the NVRAM to ensure that status is updated by controllers on the DARTnet.

DARTnet activity is displayed using decimal points for message receipt and transmission using the three display digits as follows:

Left-hand digit	Message transmitted
Middle digit	Message received in buffer 1 (indicates heavy message load)
Right-hand digit	Message received in buffer 0 (normal operation)

Refer to the relevant sections dealing with **error flags** in [DARTnet status and control](#) in the *Operation chapter* for more information on reading status information.

## Non-Volatile RAM

The non-volatile RAM (NVRAM) is a ferro-magnetic device in a DIL package. It is plugged into a socket for easy swapping between rack controllers. It contains all the information for the frame that it was controlling.

The NVRAM can be reset using the function switch (see above). This is useful when a rack controller is first used.

## EPROM

The EPROM is used for upgrading the microcontroller's program. If, on power up, the program in the EPROM is newer than the program in the Microcontroller, it is read from the EPROM and programmed into the Microcontroller's Flash program memory. Flash programming progress is indicated by a circulating segment in the display.

## Test switch

**The 2-bit test switch SW5 should normally be set to both DOWN.**

Other settings are used for production test and in conjunction with the engineering port on the BOOT connector.

SW5	Function
UP : UP	Production test
UP : DN	DN RS232 data in/out
DN : UP	UP RS232 data in/out + I <sup>2</sup> C errors out
DN : DN	DN <b>Normal operation</b>



# Operation

The B070 module should only be used as part of a DART network. Although, it can be fitted in a frame without a DARTnet connected any modules in the frame set to REMOTE mode will be automatically set to their default values if there is no control network to set parameters.

**IMPORTANT:** If DARTnet is not being used, and a B070 is present in a frame, then all modules in that frame should be set to LOCAL.

## DART address setting

DART addresses are 6 bits of the 11-bit identifier in the arbitration field of each message and are set on two rotary switches mounted on the B070 module.

The decimal switches are accessible only when the module is removed but it is visible from the front of the frame on a 7-segment display when the module is powered.

The DARTnet address of the B070 is set using the two rotary switches SW3 and SW4 to make up a 2-digit decimal number from 0010 – 9910. Only numbers 0010 – 6210 are valid DART addresses and some of the higher addresses are reserved for DARTnet controllers. Address 6310 is used to indicate a 'Broadcast' message, that is, one that should be accepted by every control node on the network, and must not be used for frames or controllers.

The address is only read when the microcontroller first boots up, normally on power up.

**Note:** Although the B070 must be removed to change its address, if access to the switches is possible with power still applied, it is essential to press RESET (SW2) momentarily whenever the address is changed.

## DARTnet speed

DARTnet has two operating speeds. The preferred speed for all networks is 250kbits/sec, but on long networks there can be a problem with higher error rates. CAN 2.0B automatically handles transmission errors by using error correction techniques and data re-transmission, which is transparent to the user. For network lengths up to 150m, 250kbit/s can be used, between 150m and 500m, 125kbit/s should be used. It is important that all nodes on the network operate with the same speed setting. Jumper JP3 is linked to set the CANBUS to run at the lower speed.

In practice, the vast majority operate successfully at 250kbit/s.

## DARTnet status and control

When connected to a DARTnet the B070 looks like two modules, in slots 0 and 15, in a frame containing up to 14 other modules. Slot 0 provides PSU and Fan status to operators while slot 15 may be used by engineers to change the way the rack controller works and to monitor the integrity of the DARTbus.

### PSU/fan monitor status

The PSU/Fan Monitor status register contains the following status indications.

Bit	7	6	5	4	3	2	1	0
Byte 0					Fan Status		PSU 2	PSU 1

PSU 1 and PSU 2 will be set to '0' if their voltages are 13v or higher, '1' if lower (failed). Fan Status is '0' if running normally, '1' if failed or '2' if running fast (to reduce temperature or compensate for a single fan failure).

### Control and status

The control and status registers contain the following controls.

Bit	7	6	5	4	3	2	1	0								
Byte 0	reserved															
Byte 1									Refresh Rate							
Byte 2																
Byte 3									Heartbeat Rate							

**Refresh Rate** controls how often a Rack Scan takes place. A Rack Scan occurs when data in the rack controller is written to the modules on a regular basis and when module status is checked for changes.

The faster the refresh rate, the sooner a module status change is broadcast but the greater the possibility of clogging DARTnet with changing status indications in large networks. The default rate is 2 seconds, however, the status response to a changing control is faster since the B070 automatically reads status when a control is detected to have just stopped changing.

Refresh Rate: 00=2 sec, 01=1 sec, 10=500ms, 11=250ms.

**Heartbeat Rate** controls how often a node heartbeat is broadcast on DARTnet to indicate the continued presence of the frame in the network. The faster the heartbeat rate, the sooner a DARTnet controller can recognise the presence or absence of a frame in the network but the more traffic is generated on the DARTnet. The default rate is 10 seconds.

The first heartbeat occurs once the frame is powered, just after the broadcast message that indicates the frame is booting. This enables more rapid detection of frames on networks.

Heartbeat Rate: 00=10 sec, 01=5 sec, 10=30 sec.

### DARTbus Integrity

The B070 responds to three refreshed read messages and a single refreshed write message to provide status and control for its DARTbus integrity monitoring.

#### Message 0 (read only)

Bit	7	6	5	4	3	2	1	0
Byte 0	1:Class 7		Slot 1 DER					
Byte 1	2:Class 7		Slot 2 DER					
Byte 2	3:Class 7		Slot 3 DER					
Byte 3	4:Class 7		Slot 4 DER					
Byte 4	5:Class 7		Slot 5 DER					
Byte 5	6:Class 7		Slot 6 DER					

#### Message 1 (read only)

Bit	7	6	5	4	3	2	1	0
Byte 0	7:Class 7		Slot 7 DER					
Byte 1	8:Class 7		Slot 8 DER					
Byte 2	9:Class 7		Slot 9 DER					
Byte 3	10:Class 7		Slot 10 DER					
Byte 4	11:Class 7		Slot 11 DER					
Byte 5	12:Class 7		Slot 12 DER					

#### Message 2 (Read), Message 3 (Write)

Bit	7	6	5	4	3	2	1	0
Byte 0	13:Class 7		Slot 13 DER					
Byte 1	14:Class 7		Slot 14 DER					
Byte 2	ER8 On	ER7 On	ER6 On	ER5 On	ER4 On	ER3 On	ER2 On	ER1 On
Byte 3	Error Rates Select		ER14 On	ER13 On	ER12 On	ER11 On	ER10 On	ER9 On
Byte 4	Not Used							Retries off
Byte 5	Not Used							

A 7-bit DARTbus Error Rate (**DER**) is maintained for every slot as long as its **Error Rate On (ER On)** control is active. The **Error Rates Select** control can be set to 00 ALL OFF, 01 SELECT or 10 ALL ON. In the SELECT position, the individual ER On controls are used. A DER is cleared if its ER On control is OFF. Bit 7 in each byte is used to indicate whether the module in that slot is Class 7 or not.

This status may be used in a DARTnet controller to determine whether particular controls are available for older (not class 7) or newer (class 7) modules.

The **Retries Off** control is used to turn off DARTbus retries in order to check the DARTbus under rigorous conditions. In normal operation, the rack controller will try a total of 5 times when attempting a transfer on the DARTbus but with retries off, a failure after a single attempt causes an error and increases the error rate.

DARTbus Error Rates contain a count of the number of errors that occurred in 100 DARTbus transfers or attempted transfers. After each 100 transfers the current rate is added to the previously stored rate and the total halved in order to maintain a rolling average. Whenever a DER changes, the corresponding Broadcast Refreshed message (0, 1 or 2) is transmitted on the DARTbus. The controls are written using Refreshed Write message 3 with an I<sup>2</sup>C address of 10 (Hex).

### Rack Controller Heartbeat

The heartbeat, which is broadcast on the DARTnet by the rack controller every 5, 10 or 30 seconds, depending on the setting of the Heartbeat Rate, contains the following information in its 8 data bytes.

Byte	0	1	2	3	4	5	6	7
Data	B'cast	Node	PSU 2	BUS V	PSU 1	Temp	OpMode	Flags

Byte description								
B'cast	5 – rack controller heartbeat							
Node	Rack DARTnet address							
PSU 2	Volts = Data x 0.1394							
BUS V								
PSU 1								
Temp	Temp = 30 + ((data – 144) x –0.404) in °C							
OpMode Bit	7	6	5	4	3	2	1	0
	RC Type 00: V606/V1608 01: 6081		Not used	Retries 0: ON 1: OFF	Heartbeat Rate 00:10 sec 01:5 sec 10:30 sec 11:N/A		Refresh Rate 00:2 sec 01:1 sec 10:½ sec 11:¼ sec	
Flags	Not currently used – reads 00 (hex)							

**Note:** Bits in the OpMode byte distinguish between the B070/V6081 and previous rack controllers. This enables a DARTnet controller to modify its operation to take advantage of the B070's features. For instance, with a heartbeat rate of 10 seconds instead of 30 seconds, it should be able to detect a frame going off-line in 30 seconds instead of 90 seconds.

## DARTnet error handling

Error management logic is built into CAN 2.0B that confines faults to prevent a single faulty node crashing the network. In most cases, errors are handled by the CAN logic and messages are re-transmitted automatically when errors are detected either by a transmitting node or a receiving node.

However, certain gross errors can be detected by the B070 and shown on the 3-digit 7-segment display. If the error is transient or is corrected so that transmission can take place, a broadcast message is sent that indicates the type of fault that occurred.

## CANbus Error Flags

If CANbus errors are detected, the 7-segment display switches to show the error flags (Cxx) where xx is a hexadecimal representation of the error flags.

Bit	7	6	5	4	3	2	1	0
	Overflow 2	Overflow 1	Bus Off	Tx Error	Rx Error	Tx Warning	Rx Warning	Warning

**Overflow 1 and 2** indicate a message is lost because a receive buffer has overflowed. All messages normally go to the first buffer and are redirected to the second buffer if the first one is still full. This rarely happens and overflow is extremely unlikely to occur.

**Tx Warning** and **Rx Warning** are indications that significant Transmit or Receive errors are occurring. The Warning flag sets if either of these two flags is set.

**Tx Error** and **Rx Error** indicate that error counts have reached a dangerously high level.

**Bus Off** occurs if the Transmit error count reaches such a high level that the error management logic's confinement strategy dictates that the module should be isolated from the CAN bus. The module will recover from the **Bus Off** state automatically if it detects a sufficiently long idle period on the bus. The CAN error be shown as **C20**.

Intermittent faults of this type will show **C20** and **C00** alternately and this is normally indicative of a short circuit between the CAN data lines.

## DARTnet disconnection

An excessively large number of Transmit errors usually means that nothing is being transmitted by the rack controller because it is disconnected from the DARTnet. In this case, the CAN error will normally be shown as **C15**. If the fault persists for a second or more, once the fault has cleared, a DARTnet Connection broadcast message is transmitted and the display reduces to **C05** and eventually clears to **C00**.

This error can also occur intermittently if there are anomalies in the network such as unconnected cable spurs.

## DARTnet termination error

An excessively large number of Receive errors often means that the network is terminated incorrectly. In this case the CAN error will normally be shown as **C08**.

A small network with short links may work with a single termination on the network but no termination at all will cause **C08** to be shown permanently. Larger networks and those with longer links require termination at each end and, although they will work to some extent with a single termination, large bursts of receive errors will occur and may cause **C08**. If the fault has persisted for a second or more, when the fault clears or errors reduce sufficiently to allow transmission, a DARTnet Termination broadcast is transmitted and the display changes to **C03** and eventually clears to **C00**.

The termination setting is always 'live', so it can be changed without the need for a RESET.

## Program upgrades

The B070 rack controller can be upgraded using an upgrade PROM which contains all of the information required for the module's Boot loader to upgrade the rack controller's Main Program in its microprocessor's on-board Flash.

### Upgrade procedure

Install the PROM in socket U13 then insert the module into the frame and apply power (or the frame could be already powered).

The front panel display briefly shows **ChF** as the microprocessor Flash is being checked, followed by **ChP** to indicate that the PROM is being checked. If everything is correct, the display briefly shows **Era** (erasing) and then a single segment starts moving clockwise around the display as the processor Flash is programmed. If successful, the **ChF**, **ChP** sequence is repeated but this time the Flash program version will match that of the PROM so the process terminates and the frame's DARTnet address is displayed.

Sometimes, the upgrade PROM instructs the Boot loader to upgrade itself in addition to the Main Program. In this case, two programming sequences occur, the first shows that the Boot loader is being upgraded, the second shows that the Main Program is being upgraded.

**Warning:** Do not remove power during the Boot loader upgrade. This will cause the module to become unusable and it must then be returned to the factory.

Main Program upgrading will normally occur only if the Boot loader detects that: (a) the PROM is a valid upgrade PROM and (b) the Main Program version in the PROM is later than that in the Flash. This also applies to upgrading the Boot loader.

**Tip:** To allow a Main Program upgrade to occur regardless of version number, hold the function switch, **SW1**, in while power is applied. A Boot loader upgrade can never be forced in this way.

## Upgrade error indications

In the unlikely event that anything goes wrong during the upgrade process, an error number is displayed on the front panel display. The following indicates what the error numbers mean.

<b>Error No.</b>	<b>Meaning</b>
E01	Flash erasing failed
E02	Flash programming failed
E03	Main program checksum error after programming
E04	Boot loader checksum error after programming
E05	No program loaded and no valid upgrade in PROM
E06	Boot loader upgrade required but no valid boot loader upgrade in PROM

# Frequently Asked Questions

*There are frequent Cxx error flags, what do they mean and what can I do?*

These error numbers are displayed on the front panel display whenever a communication error occurs. The [CANbus Error Flags](#) section in the Operation chapter has a list of CANbus errors and their meaning.

The following checks may be useful:

Check that all frames and modules are receiving power.

Check that the recommended network length has not been exceeded for the current CANbus speed setting as explained in the [DARTnet speed](#) section of the *Operation* chapter.

Check that the network is terminated correctly as explained in the [DART termination](#) section of the *Operation* chapter. Larger networks and those with longer links normally require a 120 Ohm termination at each end though they may work with a single termination

Check that each B070 has a UNIQUE address in a multi-frame system. Refer to the [DART address setting](#) section of the *Operation* chapter.

**Note:** More error reporting is available from the engineering RS232 port when the test switch is set to the position for RS232 data in/out + I<sup>2</sup>C errors out. It provides information to an engineer when a module's DARTbus interface is malfunctioning.

One or more I<sup>2</sup>C errors may appear at the engineering RS232 port:

Error No.	Description
ERROR 08	Bus busy at end of I <sup>2</sup> C sequence
ERROR 09	Bus busy at start of write sequence
ERROR 10	Bus busy at start of read sequence
ERROR 11	Error sending START
ERROR 12	Error sending read address
ERROR 13	Error reading data bytes 0 to n-1
ERROR 14	Error waiting for 8th clock pulse on last data byte
ERROR 15	Error reading last byte
ERROR 16	No acknowledgement for read address
ERROR 17	Error sending write address
ERROR 18	No acknowledgement for write address
ERROR 19	Error sending data
ERROR 20	No acknowledgement for written data



*There are excessive Receive errors and C08 appears, what's wrong?*

This may be caused by a termination problem. Refer to the [DARTnet termination error](#) section of the *Operation* chapter for more information.

*There are excessive Transmit errors and C15 appears, what's wrong?*

The rack controller may be disconnected from the DARTnet. There may also be anomalies in the network such as unconnected cable spurs. Refer to [DARTnet disconnection](#) in the *Operation* chapter.

*I've inserted the wrong module into a slot, how can I retrieve the original setup data?*

Fortunately, the B070 remembers the original data in its 'Swap' memory so long as no other module has been changed.

**Note:** The swap memory can be cleared by pressing the rack controller's reset button, SW2, after installing the correct modules in the correct positions.

*Errors have occurred during a program update, what do they mean?*

Refer to [Upgrade error Indications](#) of the *Program updates* section of the *Operation* chapter for more information.