Using the Sequencing Bus on an NXF4000 or PPC4000 with a Third-Party Modbus Master

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The NXF4000 and PPC4000 both have a dedicated Modbus connection for the peer-to-peer sequencing bus. This connection allows up to six NXF4000 or PPC4000 controls to be connected in a daisy-chain for lead/lag sequencing. When this feature is used, one is designated as the master control and the others will receive their commands from that unit. The master can be designated using the keypad, digital inputs or by using the BMS Modbus connection.

This bus can also be used by a third-party Modbus master to command the controls on or off and to specify a firing rate. An active Modbus connection is required to maintain the remote command – if no Modbus activity is received within a 30 second timeout, the control will revert to the local source of control. This is typically either PID control using the PCV sensor or track modulation. Local control can also be indicated over a Modbus command allowing local control to be an option from the third-party Modbus master.

WIRING

The Modbus terminals for the sequencing bus are on connector P12:

P12.3: Modbus A(+)
P12.4: Modbus B(-)

Just as when using peer-to-peer sequencing, all the connected units must be wired in a serial string, also known as a “daisy-chain”. This means that each control is connected to the next, and only the first or the last control is connected to the Modbus master device.

CONFIGURATION

Sequencing must be enabled for this method to work. It is also important that no control is specified to be the master, and that the LEAD LAG key on the keypad is disabled so that a master isn’t inadvertently specified in the future. If a master does get enabled there will be communication issues from the third-party Modbus master.

The sequencing bus has communication settings fixed at 19200 baud, eight data bits, no parity and one stop bit. The node address for the sequencing bus is the same as the node address used for the BMS Modbus port. Note that because of this, there needs to be two Modbus master ports on the third-party Modbus master if connecting to both the BMS Modbus and sequencing bus is desired, since they will always have the same slave address.

Settings:

COMMUNICATION SETUP → UNIT ADDRESS → (1-247)
SEQUENCING SETUP → MASTER SLCT → COMMS
SEQUENCING SETUP → SLAVES AVAILABLE → 0
KEYPAD SETUP → LEAD LAG KEY → UNUSED

METHOD

There is a single Modbus register in the sequencing bus. This register has read/write access.

The register is address 0 (40001). This register is read using function code 3. Any read request must only have a length of one or an exception response will be generated.

The third-party Modbus master must be able to parse the 16-bit result into two 8-bit bytes in order to read the current status. These are designated as most-significant byte (MSB) and the least-significant byte (LSB).

Example (read address 0, length 1, node 2):

```
Message: 02 03 00 00 00 01 84 39
Response: 02 03 02 64 05 16 87
```

The response has two bytes (highlighted in yellow). Also note that the CRC bytes for the Modbus messages are highlighted in gray. Read as a 16-bit unsigned integer, this value is **25606**. Convert this to hex and the value is **0x6405**. The MSB has a value of **0x64** and the LSB has a value of **0x06**. The MSB indicates the firing rate. To read, convert 0x64 into decimal and the result is 100. This indicates a firing rate of 100%. This value could be anywhere from 0% to 100%. The LSB indicates the current status, which is an enumerated value with the following meanings:

1: Not available to sequence (burner on/off switch is off, or control is locked out)
2: Not used
3: Available to sequence but no call for heat (internal stat, recycle limit input or sequencing master disable)
4: In process of starting (purge, ignition, PTFI or MTFI)
5: Running using local settings (PID or track)
6: Running as sequenced slave

In the example above, the status of 0x06 can be converted to a decimal value of 6. This indicates that the control is running as a sequenced slave.

Sending a command to the control works similarly. A message is written to register 0 using function code 6. The MSB contains the desired firing rate and the LSB contains the desired operating status.

The status values that can be written:

3: Sequenced slave disabled
5: Run using local settings (PID or track)
6: Sequenced slave enabled

When sending a status of 3 or 5, the firing rate send does not matter.

Example (write address 0, node 2):

```
Message: 02 06 00 00 00 03 C9 F8
Response: 02 06 00 00 00 03 C9 F8
```

This message sends a disable command (status 3). Note that the firing rate is ignored and that the response for a message with function code 6 should mirror the original message.

Example (write address 0, node 2):

```
Message: 02 06 00 00 32 06 1C 9B
Response: 02 06 00 00 32 06 1C 9B
```

This message sends a command to run as a sequenced slave at 50% firing rate. The value 0x32 has the decimal equivalent of 50, and status 6 is the command for enabling a sequenced slave.

There needs to be a form of Modbus activity (read or write) at least once every 15 seconds in order to keep the remote sequencing command active. If this does not occur, there will be a timeout and the control will revert to local control (same as status 5). Status 5 can also be intentionally written if local control is desired while still maintaining a Modbus connection. The best practice is to continuously read or write to the sequencing bus if it is being used.

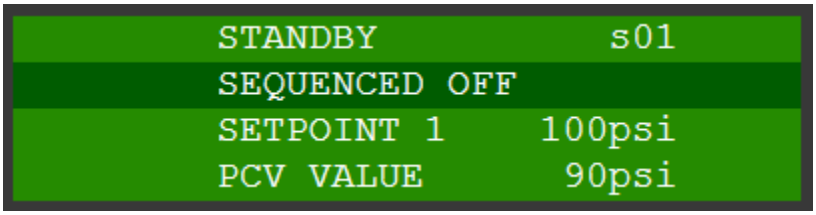
A simple way to create the combined 16-bit value needed when writing to address 0 is to take the desired firing rate, multiply by 256, then add the status. For example, to send a command of 50% with status 6, multiply 50 x 256, then add 6. This yields a result of 12806 (0x3206). There is not a similar shortcut to parse the 16-bit value back into two bytes.

PRIORITY

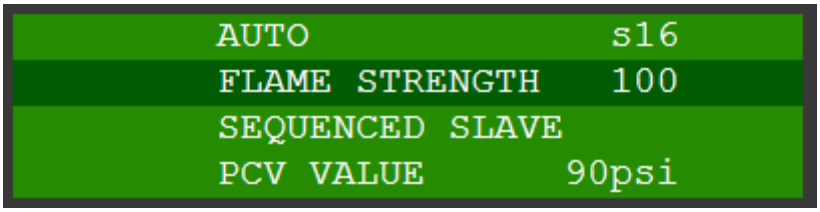
Manual modulation has priority over the sequenced slave commands. This also means any BMS Modbus commands to control the AUTO MAN key or the manual modulation rate will also have priority over the sequenced slave commands. If using the sequencing bus to control enable and modulation, do not also use the BMS Modbus registers to do the same.

MESSAGES

The NXD410 or NXD410TS will display a message on the home screen to indicate the current sequencing command status.

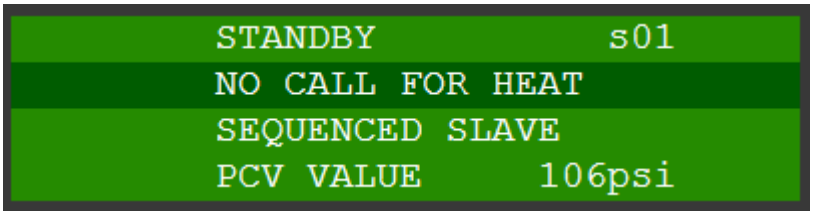


Status 3 message (sequenced slave disabled)



Status 6 message (sequenced slave enabled)

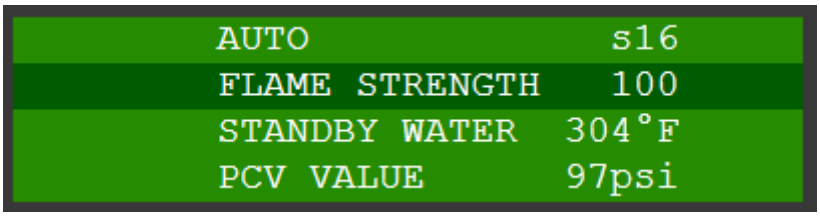
Note that the internal stat (cut-in and cut-out) is still respected when sequenced slave is enabled.



Status 6 message (sequenced slave enabled but the PCV is greater than the setpoint plus cut-out)

HOT STANDBY

If sequencing is used, sensor 2 can be connected to a shell temperature sensor to enable the hot standby feature. Setpoint 2 is configured to the standby setpoint and whenever the sequenced slave disable command is sent (status 3), the control will override this to maintain the standby water temperature.



Message when sequenced slave is disabled but hot standby is active

To enable hot standby:

SENSOR SETUP → SENSOR 2 → TYPE → STANDBY
SENSOR SETUP → SENSOR 2 → RANGE → (choose sensor range)
SETPOINT SETUP → SETPOINT 2 SETUP → SENSOR USED → 2

Enter the desired setpoint, cut-in, cut-out and PID settings as desired. Note that setpoint 1 and setpoint 2 each have individual settings.