CLAIMS

1. A method of testing a solenoid of a directional control valve in a subsea hydrocarbon production system, the solenoid having a coil and an armature for operating the valve and the coil being energized by a drive voltage across it, the method comprising:

   reducing the drive voltage to a voltage greater than zero, wherein the drive voltage is reduced by pulse width modulation of voltage applied by drive circuitry for the solenoid, and wherein the pulse width modulation comprises providing a train of square wave pulses, wherein each square wave pulse has a magnitude of full supply voltage, and wherein each pulse in the train of square wave pulses is of a progressively shorter duration than a previous pulse for each of the square wave pulses; and

   sensing current through the coil to produce an indication of movement of the armature to test the solenoid;

   wherein the indication is produced by detecting a perturbation of the current due to a change in the inductance of said coil due to movement of the armature.

2. The method according to claim 1, wherein the drive voltage is reduced by a processor in a subsea electronics module of a subsea control module.

3. The method according to claim 1, wherein if the drive voltage is reduced but the indication is not produced before the drive voltage reaches zero, the voltage is increased to the drive voltage and then reduced again.

4. The method according to claim 1, wherein voltage is returned to the drive voltage in response to the indication.

5. A method of testing a solenoid of a directional control valve in a subsea hydrocarbon production system, the solenoid having a coil and an armature for operating the valve and the coil being energized by a drive voltage across it, the method comprising:

reducing the drive voltage to a voltage greater than zero, wherein the drive voltage is reduced by pulse width modulation of voltage applied by drive circuitry for the solenoid, and wherein the pulse width modulation comprises providing a train of square wave pulses, wherein each square wave pulse has a magnitude of full supply voltage, and wherein each pulse in the train of square wave pulses is of a progressively shorter duration than a previous pulse for each of the square wave pulses; and

sensing current through the coil to produce an indication of movement of the armature to test the solenoid, wherein the indication is produced by detecting a perturbation of the current due to a change in the inductance of the coil due to movement of the armature and if the drive voltage is reduced but no such indication is produced before it reaches zero, the voltage is increased to the drive voltage and then reduced again.

6. The method according to claim 5, wherein the drive voltage is reduced by a processor in a subsea electronics module of a subsea control module.

7. The method according to claim 5, wherein voltage is returned to the drive voltage in response to the indication.

8. A subsea hydrocarbon production control system, the system comprising:

a directional control valve comprising a solenoid having a coil and an armature for operating the valve;

a mechanism for applying a drive voltage across the coil for moving the armature; and

a testing module, wherein the testing module comprises a mechanism for reducing the drive voltage to a voltage greater than zero, a sensing mechanism for sensing current through the coil to produce an indication of movement of the armature to test the solenoid, wherein the drive voltage is reduced by pulse width modulation of voltage applied by drive circuitry for the solenoid, and wherein the pulse width modulation comprises providing a train of square wave pulses, wherein each square wave pulse has a magnitude of full supply voltage, and wherein each pulse in the train of square wave pulses is of a progressively shorter duration than a previous pulse for each of the square wave pulses;

wherein the sensing mechanism comprises a mechanism for producing the indication by detecting a perturbation of the current due to a change in the inductance of the coil due to movement of the armature.

9. The system according to claim 8, wherein the testing module is adapted to increase the voltage of the drive voltage and then reduce the drive voltage again if the indication is not produced before the drive voltage reaches zero.

10. The system according to claim 8, wherein the testing module is adapted to return voltage to the drive voltage in response to the indication.

11. The system according to claim 8, wherein the mechanism for reducing the drive voltage comprises a processor in a subsea electronics module of a subsea control module.

12. The method of claim 1, further comprising:

monitoring current through the solenoid coil to detect a spike in the current flow when the drive voltage of the solenoid coil is being reduced; and

returning the drive voltage to full supply voltage upon detection of the spike in the current flow.

13. The method according to claim 12, wherein the spike in the current flow is produced when the current through the solenoid coil reduces to a level at which the armature begins to move towards its return state.

14. The system of claim 8, further comprising:

monitoring current through the solenoid coil to detect a spike in the current flow when the drive voltage of the solenoid coil is being reduced; and

returning the drive voltage to full supply voltage upon detection of the spike in the current flow.

15. The system of claim 14, wherein the spike in the current flow is produced when the current through the solenoid coil reduces to a level at which the armature begins to move towards its return state.