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Design, manufacture and test of 20 kA binary current leads for the HFML 45 T hybrid magnet

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The High Field Magnet Laboratory has designed, manufactured and tested a pair of 20 kA binary vapour cooled/superconducting current leads for the superconducting outsert magnet of its 45 T hybrid magnet system, in close collaboration with the National High Magnetic Field Laboratory (FL, USA). The resistive section of each lead consists of 22 parallel copper plates cooled by a flow of nitrogen vapor evaporating from a level controlled liquid nitrogen reservoir. As shown during the test at the HFML of similarly cooled 20 kA binary leads for NHMFL's Series Connected Hybrid this cooling scheme ensures a very stable temperature of about 77 K at the transition from the resistive section to the warmest part of the HTS section. The HTS section is made up of 60 pre-soldered stacks of 4 Ag/Au sheathed Bi-2223 tapes. These stacks are soldered simultaneously into machined slots of a stainless steel cylinder and onto both the 77 K copper interface and the 5 K copper bus bar connector block. The dedicated test facility at HFML provides the required current, a level controlled liquid nitrogen supply, and a closed-loop supercritical helium supply at 5 K and 5 bar. A test assembly is made, including the pair of current leads, an actively cooled jumper made from an aluminum stabilized NbTi Rutherford type of cable, instrumentation and mounting hardware. In this paper we present details of the design and manufacture of the current leads and the test facility and report results from the powering tests including measurement of the temperature, current and field safety margins for the HTS section and the response to loss of coolant.

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