CAPRIS Nova 800 Series

UV Laser Wire Marking Systems

Technical Specification

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1. SUMMARY

The *CAPRIS* Nova 800 series is Spectrum's 5th generation range of high performance laser wire marking products. Nova 800 supersedes and extends the range of Spectrum Wire Markers previously covered by the *CAPRIS* 60-200, *CAPRIS* 50-300 and *CAPRIS* 50-300ES systems.

The Nova 800 series comprises the following 5 distinct models:

- The Nova 800 is the entry level marker offering a system with throughput performance halfway between the *CAPRIS* 50-100 and Nova 820 systems, with the enhanced technical features of the Nova family.
- The Nova 820 is the next higher model, the equivalent of the *CAPRIS* 50-300 system, offering the same productivity with enhanced technical features.
- The Nova 840 is the next higher model, the equivalent of the *CAPRIS* 50-300ES system, offering the same productivity with enhanced technical features.
- The Nova 860 is the next higher model, the equivalent of the *CAPRIS* 60-200 system, offering the same productivity with enhanced technical features.
- Nova 880 is the top of the range system and offers a step increase in performance over the *CAPRIS* 60-200 and is aimed at the highest throughput users.

One of the benefits of the Nova 800 series is the ability to offer enhanced features either as standard or as options across the range of productivities. In addition it is possible to upgrade from a lower productivity system at a later date, giving flexibility in meeting increasing production capacity requirements.

There are two main configurations for Nova systems:

- Nova Manual systems
- Nova Automated systems

The difference between the two configurations is the way wires are held and loaded into the system. In the manual range, a single dereeler holds a single wire spool and wires are set up and manually loaded into the marker; new wire reels are changed over and set up manually. In the automated range, multiple reels of wire are loaded on a multi-station dereeler integrated with a new design Auto-Select and Load (ASL) unit. The dereeler allows from 3 up to 32 different wires and cables to be pre-loaded on the system at any one time. Preloaded wires may then be automatically selected under computer control, as required, and rapidly changed over and loaded into the Nova system marking slot. This configuration enables sufficient wires and cables to be set up and available to support production of harnesses without having to continually stop and change over wire reels.

Nova systems are the fastest, highest performance, solid state UV laser wire markers in the world. The Nova 880 exceeds the throughput performance of the benchmark *CAPRIS* 100, which has been the workhorse for aerospace wire harness production for both commercial and military programmes worldwide.

The Nova offers an economical system using the latest technology to meet the demands of today's aerospace industry for cost effective solutions for higher volume harness manufacturing applications, either as part of a mainstream harness production line or for cellular manufacture. Nova wire markers are qualified with Boeing to BAC 5152 and meet the requirements of key aerospace standards - SAE AS 5649 "Wire And Cable Marking Process, UV Laser" and European standard

EN4650 "Wire And Cable Marking Process, UV Laser" for Airbus, as well as and other OEM specifications.

Spectrum is a laser systems integrator dedicated to the design, development, and worldwide supply and support of integrated turnkey industrial laser systems. Spectrum has particular expertise in and has pioneered the development and introduction of UV laser wire and fibre optic cable marking and processing technology to the aerospace industry. The Company takes full responsibility for the design and manufacture of the complete system, including the laser and marking unit and has a full in house capability to cover all technical areas, including the UV laser marking process.

The Company has developed and introduced its own proprietary Longbow solid state UV laser. This is the first industrial UV laser to be developed specifically for aerospace wire marking applications and offers a major improvement in the performance/cost ratio of wire marking systems, making *CAPRIS* systems the most cost effective products on the market. During 2007, a further enhanced version of the laser – Longbow-2 was launched and features in all of the Nova products.

Spectrum Technologies is the world leader in the manufacture and supply of UV laser wire marking and processing equipment for the aerospace industry, having delivered nearly 1000 laser wire marking systems worldwide at the date of this document.

CAPRIS systems are based on a family of modular laser wire marking and wire processing equipment, which offer a flexible choice of system configurations from basic semi-automatic stand-alone units to fully automated wire processing systems. This enables customers to choose systems meeting their individual needs from a range of standard, proven products, covering low volume manufacturing and maintenance operations through to high volume production.

Spectrum Technologies was originally established in 1989 as a subsidiary of BAE Systems to develop, manufacture and sell state of the art industrial UV laser systems, based upon the discovery and development in 1987 of the UV laser wire marking process at BAE Systems by a team led by Spectrum's founder and current Managing Director. In 1994 Spectrum was the subject of a management buyout following which BAE Systems retained a 20% stake.

The company occupies a 20,000 sq. (2000 m^2) high-tech manufacturing facility in Bridgend, United Kingdom where the company undertakes research, development and manufacture of its products. Spectrum Technologies USA Inc., the Company's US subsidiary, is head-quartered in Fort Worth, TX, USA with additional in country service support in Mexico. Spectrum Technologies Asia Pacific is located in Shanghai, China.

Spectrum provides a full after sales support service to all its customers Worldwide. European customers are serviced by a team operating from the Company's UK factory. Spectrum Technologies USA Inc. operates a separate team of full time service engineers operating from its offices in Ft Worth, TX and from Mexico, providing total support to customers throughout North America. Spectrum Technologies Asia Pacific operates from offices in Shanghai with additional service out of Beijing, China. Consumables and spare parts are held in Bridgend, UK, Fort Worth TX, USA and Shanghai, China and may be shipped for next day delivery to most locations worldwide.

CAPRIS laser wire marking systems have been designed specifically to meet the requirements of the aerospace industry for reliable, cost effective, automated wire and cable marking and processing. *CAPRIS* systems employ the proven non-aggressive, permanent UV laser wire marking process developed by Spectrum Technologies.

2. Nova SYSTEM SPECIFICATION

2.1 Nova System Configuration

The Nova 800 series products are fully integrated, turnkey, solid state UV laser wire marking systems. In the basic system wires are loaded manually by the operator; it comprises the following subsystems, as standard:

2.1.1 Nova 800/820/840 Systems

- Single station passive dereeler
- Solid state Longbow-2 UV laser
- Character generating optics and mask unit
- Precision wire transport and processing unit
- Knot and splice detection system
- Control system, including computer
- Single powered coil pan
- Remote Maintenance Access

Figure 1. Manual wire load Nova 820

2.1.2 Nova 860/880 Systems

- Single station powered dereeler
- Solid state Longbow-2 UV laser
- Character generating optics and mask unit
- Precision wire transport and processing unit
- Knot and splice detection system
- Control system, including computer with touch screen control
- Single powered coil pan with operator motion detector
- Remote Maintenance Access

Optionally the Nova laser wire markers may be configured as fully automated systems to include multi-station dereeler and auto select and load modules for fully automatic wire loading and changeover, handling up to 32 separate reels of wire.

Figure 2. Automated Nova 880 with 32 station dereeler and 32 station ASL wire Auto Select & Load facility.

2.2 Nova System Throughput and Productivity

The Nova wire processing rates and overall performance are determined by the performance of the wire handling system in combination with the laser marking system. The wire handling system is designed to enable the system to accelerate and decelerate rapidly to and from its maximum speed without over-tensioning the wire, thereby ensuring that wire can be fed through the system at the maximum rate demanded by the marker.

To ensure that wire codes are marked correctly the system controller adjusts the wire speed to accommodate parameters including inter-character pitch and spacing between wire codes. Actual maximum wire speed and therefore wire throughput is dependent upon these marking parameters.

The Nova maximum marking speeds depend on a number of factors including:

- Length of the wire to be processed: Shorter wires, i.e. less than 0.5 m (18 inches) cannot achieve the maximum speed because the system does not have time to accelerate to reach full speed before it has to decelerate and stop.

- Number of characters in the wire code: the greater the number of characters the slower the system must run to enable all characters to be printed correctly. Long codes in excess of e.g. 20 characters, as might sometimes be used on multi-core cables, will begin to have a noticeable effect on performance.

- The spacing between wire codes: short spacing such as 75 mm (3 inches) will cause the machine to run slower than with a long spacing between codes. To maximise system speed and throughput it is useful to increase the spacing between codes where possible in the wire mid-zone, i.e. after the first 1 metre (3ft) from the wire ends to e.g. 380 mm (15 inches). Very short spacings of e.g. 25 mm / 1 inch will have the worst effect on system performance and should be avoided if at all possible.

The Nova 880 and Nova 860 systems have a maximum marking speed of 120 m/minute (394 ft. /minute). The Nova 840 and 820 systems have a maximum non-marking speed of 56 m/minute (184 ft. /minute) and a maximum marking speed under optimum conditions of over 30 m/min (98 ft. /min). The Nova 800 system has a maximum non-marking speed of 20 m/min (65 ft. /min) and a maximum marking speed under optimum conditions of over 15 m/min (49 ft. /min). However, the average throughput gives a more realistic indication of actual system productivity than the maximum speed, as it takes into account the job related data including the actual quantity of information to be printed, as well as the spacing between wire codes and wire lengths etc., all of which affect the time to process wire. Throughput is an average figure arrived at by timing the production of wire from start to stop.

The average measured wire throughput for the Nova systems are as follows:

- Nova 880: 20 to 60 m/minute (65 to 197 ft./min)
- Nova 860: 20 to 38 m/minute (65 to 123 ft./min)
- Nova 840: 8 to 28 m/minute (26 to 92 ft./min)
- Nova 820: 8 to 20 m/minute (26 to 66 ft./min)
- Nova 800: 6 to 15 m/minute (20 to 49 ft./min)

Lower throughputs will be achieved when close pitching marks along the full wire length, e.g. to meet military specifications as follows:

- Nova 880: 21 to 40 m/minute (69 to 130 ft./minute)
- Nova 860: 21 m/minute (69 ft/minute)
- Nova 840: 16 m/minute (53 ft/minute)
- Nova 820: 9 m/minute (30 ft/minute)
- Nova 800: 7.5 m/minute (25 ft/minute)

Higher throughputs are achieved particularly when using wide spacing in wire mid-zones (250 mm/10 inches or greater) through use of Spectrum Technologies ISC (intelligent speed control) algorithm, which maximizes the speed and efficiency of the system.

The system throughput is determined by the maximum wire speed and the length of the wire for any particular job. To find the system performance it is necessary to run representative tests with specific wire codes of a given number of characters and code spacing's and for various wire lengths. From this information a wire throughput chart can be constructed; examples of typical commercial and military (continuous close coded markings) are shown in Figures 3 and 4.

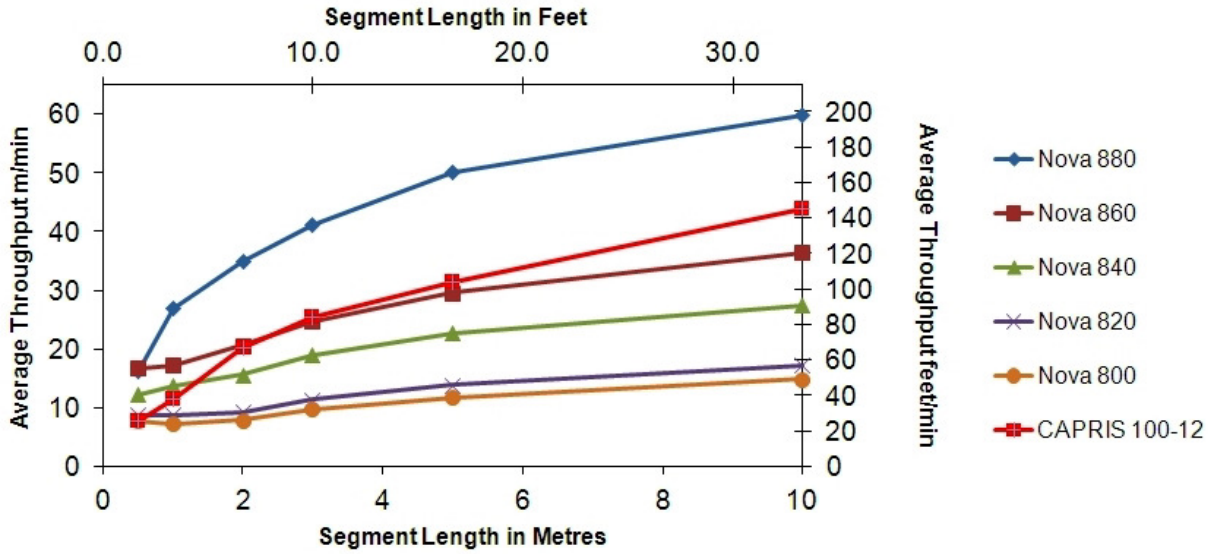


Figure 3. Nova system throughput, commercial set up with combined short and long mark spacing. NOTE: Throughput will increase for shorter codes e.g. Airbus 9 character codes.

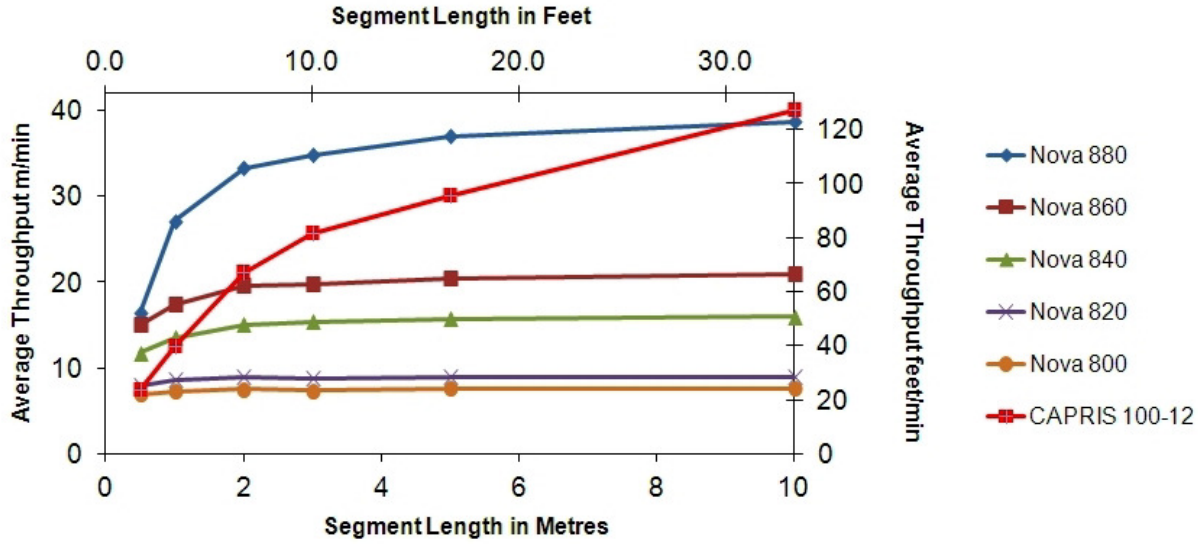


Figure 4. Nova system throughput, military set up with continuous close coding.

The above throughput figures are based on continuous utilisation of the equipment, but this allows a clear comparison between our products and with other manufacturers' equipment. To establish actual productivity of the equipment it is necessary to take into account utilisation factors including set ups, wire changes and operator factors such as administration of paper work, breaks etc.

Experience with our systems as used by a range of aerospace end users suggests a typical overall productivity (or more), per 8 hour shift of:

- Nova 880 of 9 km / 30,000 ft.
- Nova 860: 6.2 km / 20,000 ft.
- Nova 840: 4 km / 14,000 ft.
- Nova 820: 3 km / 10,000 ft.
- Nova 800: 2 km / 6,500 ft.

Throughput is established by measuring the time to process wires of a given length from start to stop and dividing the wire length by the process times measured in minutes. This then takes into account acceleration and deceleration of the wire and the time taken for cutting and data handling.

NOTE: Some competitors do not provide the same level of information and try to disguise system performance by referring only to the maximum speed in the most optimistic scenarios – please make sure that you have clear data when making comparisons. We will be pleased to run tests specific to your own set up to establish precise performance levels if required. We can also provide other examples of throughput charts from tests already carried out and can provide charts in both imperial and metric format.

2.3 Laser Marking Module (LMM)

The products that make up the Nova 800 series form Spectrum Technologies' 5th generation range of laser marking systems for aerospace wire harness manufacturing applications. Designed for high volume harness production the Nova is a fully integrated turnkey system offering automatic mark, measure and cut to length capability for single core wire and jacketed multi-core cable. The PC controlled system has an easy to use Windows interface with optional touch-screen.

Spectrum Technologies proprietary mask and optical beam delivery system are coupled with the laser to achieve the specified wire marking throughput.

The system offers maximum marking flexibility with a full alphanumeric character set and four print sizes in two print orientations (horizontal and vertical print) as standard.

A key advantage of the Nova single character per pulse marking method is the enhanced print flexibility that the system affords. In particular, no design limit on the number of characters in the identification codes (analogous to ink jet); the current software setting allows codes of up to 96 characters to be marked; optionally this may be extended to 200. This flexibility also allows the marking of separate Pin and Connector numbers directly on the wire ends to facilitate routing and connector make up, in addition to the main wire identification label, thereby simplifying harness assembly.

The solid state laser technology utilised in Nova requires no day-to-day consumables and only simple routine maintenance. The laser marking module comprises the following key elements:

- Solid state Longbow-2 laser (Longbow LC laser for Nova 800)
- Character generating optics and mask unit

2.3.1 Longbow-2 UV laser

CAPRIS laser wire markers incorporate a pulsed ultraviolet laser for marking the wire. Nova markers use Spectrum's proprietary Longbow-2 and Longbow LC solid state frequency tripled Nd: YAG (Neodymium/YAG) lasers operating at 355nm in the UV.

The Longbow laser is the state-of-the-art and has been developed specifically for UV laser wire marking applications. It is designed with a high efficiency optical system which enables the use of a single laser rod and flash lamp up to the highest powers. This simplifies and eases system maintenance and minimises running costs. Laser performance is specified according to overall system requirements to meet customer needs for wire throughput.

The laser design provides maintenance personnel easy access to all components including the harmonic generation crystals to facilitate maintenance in the field if required.

Flash lamps are rated for 30 million pulses, although they may well extend well beyond that. Spectrum Technologies recommends that users change flash lamps on an annual basis, as part of a preventative maintenance programme, unless they require changing earlier due to high utilisation rates. Changeover time should be approximately 15 to 20 minutes for trained personnel.

The Nova 800 utilises a simpler linear cavity LC laser of a similar design to the Longbow-2 laser. This lower power laser is tailored to the needs of our entry level machine. Like its higher power Longbow-2 cousin, the Longbow LC laser is also qualified with Boeing (to BAC 5152) as well as meeting major international and OEM specifications.

2.3.2 Character generation: mask unit

The Nova prints a single character with each pulse of the laser. Characters are generated by transmitting the laser beam through a custom mask unit. This contains a single precision etched circular stainless steel mask, which is analogous to a stencil.

All the required characters are positioned around the edge of the mask, which spins round to position the required character prior to firing the laser. The mask is fully encoded and its position is known at all times. This ensures that the correct code is printed on the wire.

NOTE: the stainless steel mask has an unlimited lifetime and should not need replacing; thereby avoiding unnecessary consumable and maintenance costs compared with other laser marking systems.

The standard Nova provides a full upper case alpha-numeric character set. Custom masks are available on request providing other character sets, including lower case marking if required, to meet specific customer requirements.

2.3.3 Optical system

The optical beam delivery system including the laser and mask unit are contained within a dust free enclosure. All optics used in the system are high quality UV laser grade fused silica. Mirrors are made with high damage threshold dielectric coatings.

Alignment aids are provided with the system for initial set up and maintenance. These enable easy alignment and set up of the laser beam through the optical system and mask.

NOTE: Special attention has been paid to the design of the laser and the harmonic generation optics to ensure that the system should stay in alignment without the need for regular intervention or resorting to complex and expensive self-alignment systems.

2.3.4 Laser marking fluence

The laser wire marker is pre-set and calibrated at the factory for a laser marking fluence of 0.9 J cm^{-2} to operate within the internationally agreed range of 0.8 to 1.2 J cm^{-2}. This fluence level ensures satisfactory wire marking is achieved on the wires with optimum contrast without exposing the wires to excessive UV laser energy that can affect the surface of the wire on some wire types, particularly ETFE extrusions.

2.4 Precision Wire Transport and Processing Unit

A precision wire transport and processing unit is integrated into the Nova laser marking unit.

The system will handle all wire gauges from 26 gauge up to 6.4mm outside diameter (1/4 inch), approximately equivalent to 6 gauge. Note that for very heavy stiff wires the dereeler system may be limited to about 8 gauge wire, 5 mm OD maximum.

The basic elements of this system comprise:

2.4.1 Precision wire length measurement system

This is provided by a precision encoder wheel that accurately measures the length of the wire passing through the system. A high resolution encoder wheel and pneumatic pinch wheel combination are employed so that wire lengths are accurately measured.

Accuracy of processed segments, either as cut lengths, or as continuous filament is typically -0%/+0.25%, maximum -0%/+0.5%. This high level of accuracy helps minimise scrap and reduce costs.

2.4.2 Wire marking anvil

A single universal anvil is employed to set up all wire gauges from 26 gauge up to 6.4mm (1/4 inch) outside diameter. This simple system allows wires of all gauges and types (single core wires and sheathed multicore cables) to be quickly and easily loaded either manually or automatically.

Typical total wire change over time for manual systems is typically 1 minute including wire reel change over.

The wire anvil is carefully designed to ensure that wire and cable is fed through smoothly and without being bent out of plane as it passes through the laser marking regions, regardless of the wire gauge. This is essential to ensure the quality of laser marking is maintained across all sizes of wires and cables.

2.4.3 Tractor drive unit

The wire handler contains a belt drive tractor unit that draws the wire through the laser marking system. This unit also incorporates an encoder system so that a comparison can be made between the encoder counts made on the tractor unit and the main encoder unit. Any discrepancy between the two indicates that the wire is slipping. If slip is above threshold (as set in the system control) the system will close down and display an error message to the operator.

Belts should typically last for several hundred km of processed wire equivalent to several months running before requiring changing, depending on wire type and on the system being properly set up system. Replacement of tractor belts is a simple operation by means of a quick change mechanism; changeover time is typically less than 2 minutes

2.4.4 Wire cutter

A heavy duty dual action pneumatic cutter provides precise and clean cutting of all wire sizes, while ensuring that the wire ends are not out of round. Blades are hardened tool steel for long life and are readily accessible for re-sharpening and/or replacement by the operator. The cutter is power operated and controlled as a function of the machine cycle.

The controller automatically compensates for the distance between the cutter and the mark head. The system is designed to minimise this distance and the length of the initial unmarked front end trim after setting up a new wire type. This again helps to reduce unnecessary scrap costs. This is particularly important when running the system with a multi-station dereeler and wire auto select and load unit to process wire 'by connector'. In this mode, wire types are frequently changed during operation. If the front end trim distance is not minimised significant scrap results.

Wire may either be processed as cut lengths or in continuous filament mode where the wire is re-wound onto a drum after processing. In this case, the cut point between wire segments is indicated by a laser generated cut mark.

2.4.5 Digital Knot and splice detector

A custom optical knot and splice detector (KSD) is incorporated in the wire handling system at the point of entry. This highly sensitive non-contact system detects all knots and splices normally encountered in the processing of wires. It may also detect minor faults and irregularities that other less sensitive systems (e.g. electrical continuity type detectors) would fail to detect, although it is not primarily designed for such. The KSD will typically detect faults causing variations of under +/-10% diameter on single core wire, +/-50% on multicore jacketed cables.

The knot and splice detector is interfaced and controlled by the system PC, which automatically pre-sets the wire fault threshold according to the wire being processed. No operator involvement is required.

The KSD design used in the Nova products is an improvement on previous models in that it uses digital control rather than analogue to detect the wire width, giving higher accuracy and eliminating false events.

2.4.6 Wire and cable wastage minimisation

With our waste reduction control system the initial end distance and marking zone is incorporated in the section previously produced as waste. Our waste has been reduced from typically 370mm/15 inches to 165mm/6.5inches on Nova 860/880 and 245mm/9.6inches on Nova800/820/840 when the end distance is 75mm/3inches.

After the front end trim further wastage is minimised via a smart software routine that begins printing of the next segment of wire before the previous segment is cut. This ensures that the only wastage is during the initial set up when a front end trim must be carried out when a new wire is loaded onto the system. This significantly reduces wire wastage.

2.5 System Safety

2.5.1 Interlocks

Fail safe interlocks are installed on all doors and removable panels providing access to areas containing the laser beam and/or moving machinery. Opening of any panel or door or leaving it in any but a fully closed position disables the system or the laser as appropriate.

There is an additional connection provided on the main control panel for an external interlock to allow the system to be connected to, e.g. a safety curtain or screen surrounding the system to enable the system to be operated safely in Class 4 mode for major maintenance or initial installation.

2.5.2 Emergency stops

Red emergency mushroom style stop buttons are provided on the front of the laser marking module and, optionally, on a flying lead at the operators work console. Other emergency stops may also be provided on other modules.

Upon operation of an emergency stop, the system must be manually reset and the correct procedure followed to enable the complete system to be restarted. Resetting of the emergency stop button alone will not restart the system.

2.5.3 Laser safety

All *CAPRIS* laser systems are designed as Class 1 laser products for use on the open shop floor, i.e. they are similar to a CD or DVD player in classification. They do not require special laser safety enclosures for operation and operators do not require any special laser related training or expertise.

The implementation of appropriate safety procedures and enclosures will be required at installation and thereafter when undertaking maintenance on the laser in Class 4 mode (i.e. with laser system open). Contact Spectrum Technologies for further advice if required.

2.5.4 Laser classification

All *CAPRIS* laser marking systems are registered with the United States Federal Drug Agency (FDA).

CAPRIS products are designed to conform to CFR Title 21, Chapter 1, sub chapter J US Food & Drug Administration Laser Product Performance Standards and to meet the requirements of European Laser Safety Standards e.g. BS:EN60825-1.

2.6 Nova System Wire Processing Capabilities

The following subsections outline the capabilities of *CAPRIS* wire markers for processing single core wire and cable:

2.6.1 Range of wires types processed

- Single core, screened and unscreened.
- Multi core sheathed, screened and unscreened.

Tape wrapped Polyimide (Kapton) wires:
- Dispersion coated PTFE (Teflon), ETFE and FEP wires
  E.g. Airbus CF
- Teflon tape wrapped (TKT/TK) e.g. Boeing BMS 13-60, Airbus DK/DM/DR/AD, M22759/80-92
- Extruded wires: PTFE (Teflon), ETFE, XLETFE (Tefzel) e.g. Boeing BMS 13-48, M22759/32 etc., or FEP

(Kapton, Teflon and Tefzel are Registered Trade Marks of Du Pont)

2.6.2 Wire and cable sizes and dimensions

Wire gauges: 0.8 mm to 6.4 mm (0.031" – 0.252") OD: 26 AWG to 6 AWG nominal

Minimum processed length:
- 15 cm (6 inch) cut mode
- 15 cm (6 inch) in continuous filament mode

Maximum processed length: 999 m (39,300 inch) (nominal)
NOTE: Wire lengths are set in 1 mm (0.04 inch) increments

Accuracy of processed length: -0%/+0.25% (typical) +0.5% (maximum)

2.6.3 Measure and cut capability for non markable wires

The Nova may be set up to process non-laser markable wire to measure and cut to the required length by turning off the marking in the wire parameter file.

2.7 Print Characteristics

2.7.1 Number of characters per wire code

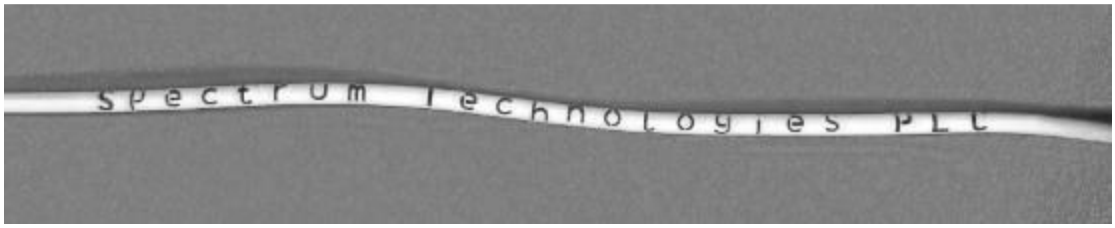
Single character per pulse marking system - no limit on the number of characters in the identification code. In general the system is configured for up to 96 characters as standard but can be configured for up to 200 characters.

2.7.2 Character set

Full upper case alpha numeric character standard set: A-Z, 0-9, plus: / \ ( ) < > $ % + - (dash) ❋ (asterisk) ■ (target square) ● (circle) and a blank space (50 in total).

Optional character set: A-Z, 0-9, plus: / \ (< > % α Δ + - (dash) ❋ (asterisk) ■ (target square) ● (circle) and a blank space (50 in total).

Other character sets including lower case available on request.



2.7.3 Character/print sizes and orientations

Four upper case print sizes available as standard (Print sizes are nominal) for all Nova machines except the Nova 800

FONT	Metric - mm	Imperial inch	Suitable for wire AWG (typical)
Large horizontal	1.6 x 1.20	0.063 x 0.047	16 and larger
Medium horizontal	1.1 x 0.82	0.043 x 0.032	18, 20, some 22
Medium vertical	1.2 x 0.90	0.047 x 0.035	22, some 24
Small vertical	1.2 x 0.60	0.047 x 0.024	24, 26, 28, some 30,

Nova 800 has a limited upper case font range compared to the other machines:

FONT	Metric - mm	Imperial inch	Suitable for wire AWG (typical)
Large horizontal	1.33 x 1.0	0.052 x 0.039	16 and larger
Medium horizontal	1.1 x 0.82	0.043 x 0.032	18, 20, some 22
Small vertical	1.0 x 0.75	0.039 x 0.030	24, 26

Optional Upper and Lower case font sizes available.

All except Nova 800
Large 1.6 x 1.2 mm (0.063 x 0.047”) – both horizontal and vertical
Small 1.2 x 0.6 mm (0.047 x 0.024”) – both horizontal and vertical

Nova 800
Large 1.33 x 1.0 mm (0.052 x 0.039) – both horizontal and vertical
Small 1.2 x 0.6 mm (0.047 x 0.024”) – both horizontal and vertical

Wire marks will be orientated with the first character toward the trailing end of the wire segment.

2.7.4 Source/destination codes (pin/connector 'ID's)

In addition to the main wire code source/destination codes can be printed separately at each end of the wire in addition to the main wire identification code.

Control over number and spacing of source/destination codes is generally as for the main wire code.

2.7.5 Mark spacing

The system can be set up by the customer for the following:

- The start and end marks can be set within 25 mm (1 inch) of the cut point/wire end. The end distance is programmable from 25 to 100 mm in 1 mm increments.

- The system is capable of both short and long (close and wide) spacing between wire codes on the same wire segment. Mark spacing may be set between 25mm and 1000mm (1 inch and 39 inches). For example, this allows wires up to 2 meters in length (6 ft.) to be marked at close spacing of 75 mm (3 inch) spacing for the first and last metre (3 ft.) and for wires longer than 2 metres (6 ft.) to be marked with a wide spacing of e.g. 380 mm (15 inch) in the mid zone between the close spaced end zones. These spacing are entirely flexible and may be set to meet customer requirements.

  The distance between wire codes is variable in increments of 1 mm (0.04 inch).

- Spacing is variable as an operator input.

- On input of a new short or long code this length will become the power up default until it is again changed.

2.8 Utilities

The system has a power requirement of 5kVa and requires the following services.

1) Electrical: 50/60Hz, 230 +/- 10% Volts (referenced to ground) supply capable of delivering 20 Amps.

For countries where 230 V is not available, a 7kVA external transformer can be supplied to accommodate 208 Volts or 480 Volts supplies. In this case it is necessary to supply:

a. 208 Volts, 40 Amps or

b. 480 Volts, 20 Amps
c. other service as agreed with the customer.

Note: The increase in current rating is to allow for nuisance tripping caused by the current inrush of the transformer primary at switch on. It is the customer's responsibility to ensure the current carrying capacity of the supply cables to the transformer are compatible with the circuit breaker rating.

2) Compressed air: dry shop air at 100 psi/7 Bar

3) Exhaust system: extraction is provided through a single 75 mm (3 inch) diameter port provided at the rear of the system. An extraction flow rate of 50m^3 per hour (30 cfm) is required.

   Alternatively an extraction module such as Spectrum's ACS-4 unit may be provided which can provide filtered extraction from the wire marker. Air passed through the ACS-4 is filtered and exhausted back into the work shop.

4) Cooling: the system comes with its own built in water cooling system which circulates water through the laser head to maintain it at the required operating temperature. The system can be supplied with an optional in-built air conditioning unit and water to water heat exchanger to enable it to operate at higher ambient temperatures (see below).

2.9 Environmental

The system should be operated under the following conditions:

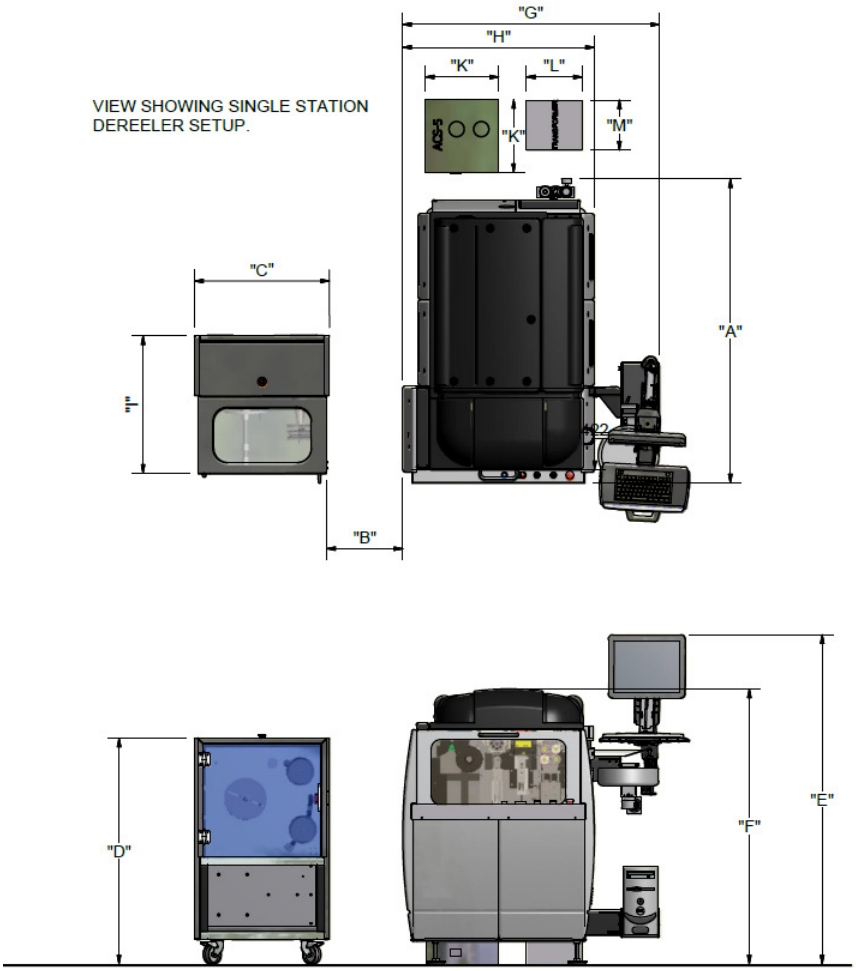
- Ambient temperature: 15°C to 32°C as standard
  15°C to 35°C (59-95ºF) with in-built air conditioning unit
  15°C to 40°C (59-104ºF) with in-built air conditioning unit and water to water heat exchanger

Note: The Nova 880 comes with in-built air conditioning as standard. For the Nova 860, 840 and 820 it is optional.

- Relative humidity: 20% to 80% (Non – condensing)

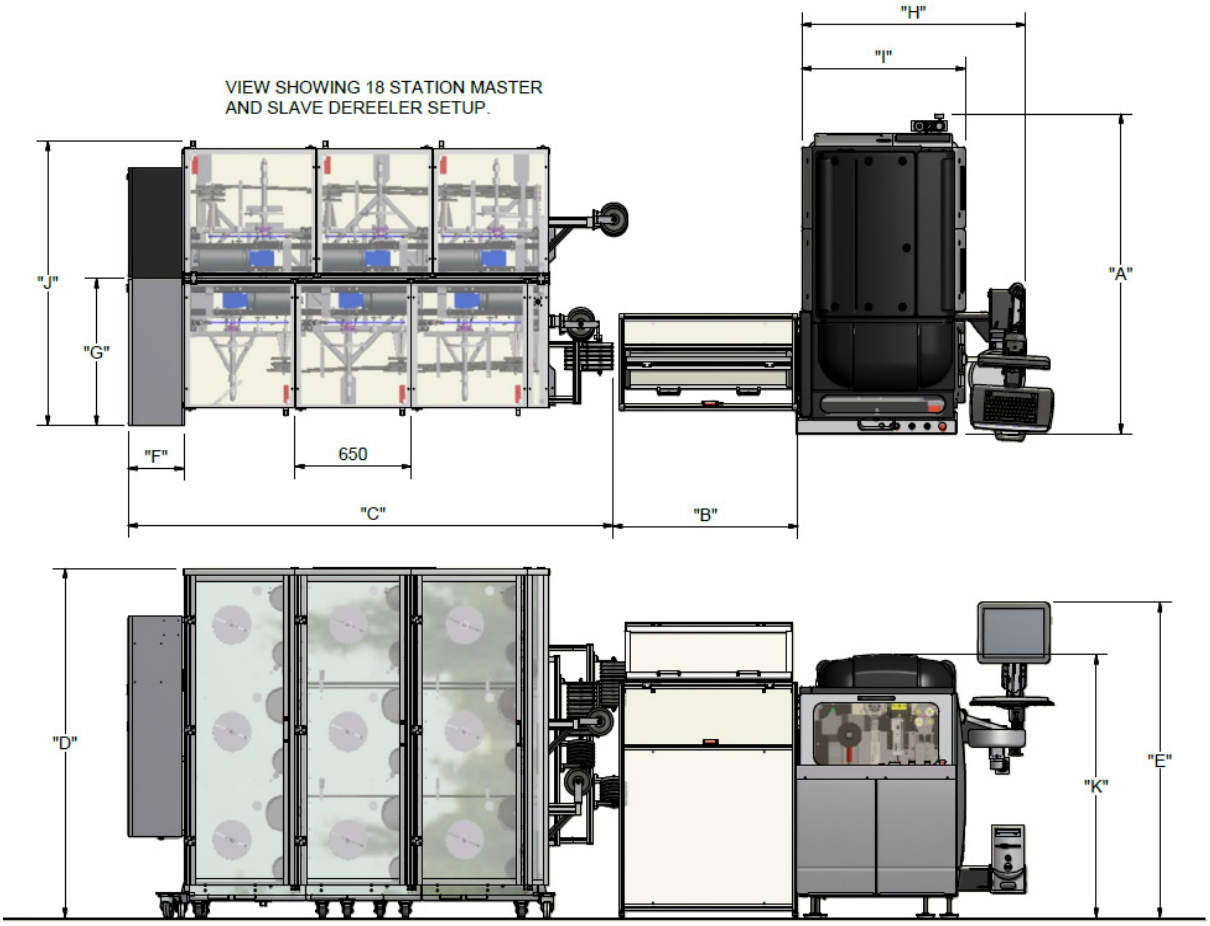
2.10 Nova 800 Series Machine Dimensions

2.10.1 Manual Nova System and Single Station Powered Dereeler



Nova Model	800 - 860	880
Denotation	Dimension Metric (mm) / Imperial (Inch)	
A	1800 / 71”	2100 / 82.7”
B	400 / 16”	400 / 16”
C	700 / 27.5”	700 / 27.5”
D	1175 / 46.3”	1175 / 46.3”
E	1700 / 67”	1700 / 67”
F	1450 / 57”	1450 / 57”
G	1500 / 59”	1500 / 59”
H	1000 / 39.3”	1000 / 39.3”
I	710 / 28”	710 / 28”
Optional Equipment		
K	380 / 15”	380 / 15”
L	290 / 11.4”	290 / 11.4”
M	260 / 10.3”	260 / 10.3”

2.10.2 ASL Nova System and Powered Multi Station Dereeler



Nova Model	800 - 860	880
Denotation	Dimension Metric (mm) / Imperial (Inch)	
A	1800 / 71”	2100 / 82.7”
B	1200 / 47.5” – 1500 / 59”	1200 / 47.5” – 1500 / 59”
C	See Multi Station Dereeler Configuration Table	
D	1900 / 75”	1900 / 75”
E	1700 / 67”	1700 / 67”
F	300 / 12”	300 / 12”
G	800 / 31.5”	800 / 31.5”
H	1500 / 59”	1500 / 59”
I	1000 / 39.3”	1000 / 39.3”
J	1550 / 61”	1550 / 61”
K	1450 / 57”	1450 / 57”

Multi Station Dereeler Configuration Table		
Master Only	Master and Slave	Dimension Metric (mm) / Imperial (Inch)
6	12	2100 / 82.5”
9	18	2720 / 107”
12	24	3340 / 131.5”
15	30	3960 / 156”
18	36	4610 / 181.5”

2.11 Nova Wire Handling Peripherals

2.11.1 Nova Dereelers

2.11.1.1 Nova UDR Passive Dereeler for use with Nova 800/820/840

A single station passive dereeler is supplied with the Nova 800/820/840 manual wire loading laser marking system as standard.

This provides controlled passive dereelering of wires and cables. The design of the dancer arm and pulley arrangement together with a brake unit provides sufficient wire payoff and back tension to the laser marking system.

- Passive dereeler capable of dereeling at up to 56 m/min (180 ft./min) – nominal for the specified drum sizes
- Dereeling synchronised to the demand from the laser wire feed system
- Quick release device provided for the rapid change of reels
- Adjustable spigot provided to locate in reel drive holes
- Provision for the discharging of static electricity (optional)
- Maximum wire/cable diameter: 5 mm (0.20 inch) nominal,
- Reel dimensions: Maximum outer diameter 400mm (16 inch)
- Maximum drum width 300 mm (12 inch)
- Minimum inner diameter 150 mm (6 inch)*
- Reel maximum weight: 20 Kg (44 lbs.)*
- Shaft size: 25 mm (1 inch) = minimum reel centre hole diameter

* Smaller inner diameter spools and reels of up to 25 kg can be used albeit at slightly reduced running speeds or acceleration of the marker unit

2.11.1.2 Nova Powered Dereeler for use with Nova 860/880

A high performance single station powered dereeler is supplied with the Nova 860/880 manual wire loading laser marking system as standard.

Powered dereelers have been developed for this application due to the need for high acceleration and deceleration to maximize throughput to keep up with the capabilities of the higher performing laser marking module. The powered dereeler system limits the load applied to the wire by regulating air pressure, or pre-loaded back tension, to a dancer arm. This prevents over-tensioning wires and problems with wires deforming, kinking or snapping found with unpowered dereelers.

The dereeler is completely enclosed to prevent operator access to rotating machinery. This also helps maintain cleanliness. An interlocked door, which inhibits the drive system from operating, allows operators safe access to change and set up wire reels.

The dereeler is fitted with a dancer arm and pulley arrangement through which wires are fed, such that wire is dereeled in synchronisation with and at the required rate to meet the demand from the laser wire marking module. The use of back tensioning on the dereelers ensures that wire is tensioned correctly at all times and ensures that the dereeler stations rapidly and smoothly cease paying out wire when demand from the laser marking module stops, without incurring problems of the drum over-running and resultant bird-nesting of the wire.

Please note the following key features of the dereeler offered here:

- Powered dereeler capable of dereeling at up to 120 m/min (400 ft./min) – nominal for the specified drum sizes
- Dereeling synchronised to the demand from the laser wire feed system
- Interlocked safety enclosure
- Quick release device provided for the rapid change of reels
- Adjustable spigot provided to locate in reel drive holes
- Provision for the discharging of static electricity (optional)
- Maximum wire/cable diameter: 5 mm (0.20 inch) nominal,
- Reel dimensions: Maximum outer diameter 400mm (16 inch)
- Maximum drum width 300 mm (12 inch)
- Minimum inner diameter 150 mm (6 inch)*
- Reel maximum weight: 20 Kg (44 lbs.)*
- Shaft size: 25 mm (1 inch) = minimum reel centre hole diameter

* Smaller inner diameter spools and reels of up to 25 kg can be used albeit at slightly reduced running speeds or accelerations of the marker unit

2.11.2 *CAPRIS* single coil pan

Following the marking of processed wire, cut lengths are collected in a synchronised, powered single coil pan of 30 cm (12 inch) diameter, which is fitted as standard; optionally a 38 cm (15 inch) diameter pan is available on request. Pans are rigidly constructed, rotate easily and will not cause the wire to hang up and will not mark or damage the wire. An optical detector can optionally be supplied to start the next wire section as the previous section is removed from the coiling pan. A tilting mechanism for the coiling pan is provided to allow the angle of the coiling pan to be adjusted to an ergonomic angle

2.11.3 Laser fluence monitor

A laser energy meter can be incorporated to measure the laser marking fluence/energy density (standard on Nova 860, 880, optional on Nova 800, 820,840). This meter is located after the beam delivery system so that it checks not only the energy from the laser but also checks for any loss of energy through the optical beam delivery system. The laser fluence meter calculates the laser energy and marking fluence delivered at the surface of the wire and checks this against the pre-set value held on the system PC. If the laser energy and fluence goes outside pre-set limits it will flag an error message to the operator. The system has maximum limits outside which it will flag an error and secondary limits which may be selected by the customer if required.

2.12 Optional *CAPRIS* wire handling and other systems

The following alternative wire handling systems are available to meet customers' requirements for automated systems or for other forms of wire handling, e.g. continuous filament operation.

2.12.1 *CAPRIS* Nova multi-station dereelers

CAPRIS Nova dereelers can be supplied in modules of 3 dereelers, from 3 up to a maximum of 32 stations for use in automated systems in conjunction with the CAPRIS ASL wire auto select and load system. (See Figure 2, Page 9).

Each dereeler station is fitted with a dancer arm and pulley arrangement through which wires are fed, so that wire is dereeled in synchronisation with and at the required rate to meet the demand from the laser wire marking module. The use of back tensioning on the dereelers ensures that wire is tensioned correctly at all times and ensures that the dereeler stations rapidly and smoothly cease paying out wire when demand from the laser marking module stops, without incurring problems of the drum over-running and resultant bird-nesting of the wire.

Please note the following key features of the dereeler offered here:

- Powered dereeler capable of dereeling at 120 m/min (400 ft./min) – nominal for the specified drum sizes
- Dereeling synchronised to the demand from the laser wire feed system
- Interlocked safety enclosure
- Quick release device provided for the rapid change of reels
- Adjustable spigot provided to locate in reel drive holes
- Provision for the discharging of static electricity (optional)
- Maximum wire/cable diameter: 5 mm (0.20 inch) nominal,
- Reel dimensions: Maximum outer diameter 393mm (16 inch)
- Maximum drum width 300 mm (12 inch)
- Minimum inner diameter 150 mm (6 inch)*
- Reel maximum weight: 20 Kg (44 lbs.)*
- Shaft size: 25 mm (1 inch) = minimum reel centre hole diameter

* Smaller inner diameter spools and reels of up to 25 kg can be used albeit at slightly reduced running speeds or accelerations of the marker unit

2.12.2 *CAPRIS* Nova wire Auto Select and Load (ASL) Unit

The Nova ASL is an optional modular unit that provides high speed fully automated selection and loading of wires into the laser wire marking unit under control from the main Nova PC controller. This capability significantly reduces machine set up time and increases system throughput when used with a multi-station dereeler.

The ASL system interfaces with the wires from the output of the multi station dereelers, typically where the dereeler has 3 or more dereeling stations. The system comprises a track mounted indexer controlled to select 1 of up to 32 positions on a wire selector unit. The wires are pre-loaded in the ASL so that a minimum number of steps are required to change wires. This significantly reduces the loading time compared to previous designs and greatly improves the load/unload reliability. Wire changeover times are typically 10 seconds or less.

2.12.3 *CAPRIS* R500E rereeler unit

The *CAPRIS* R500E powered rereeler has been developed for use in situations where customers wish to operate in continuous filament mode, i.e. without cutting the wire. The system is designed to match the high acceleration and deceleration of the laser marker and to maximise system throughput. The powered rereeler system offered here limits the load applied to the wire to prevent over-tensioning wires and problems with wires deforming, kinking or snapping

The rereeler is completely enclosed to prevent operator access to rotating machinery. This also helps maintain cleanliness. An interlocked door, which inhibits the drive system from operating, allows operators safe access to change and set up wire reels.

The rereeler is fitted with a dancer arm and pulley arrangement through which wires are fed, such that wire is rereeled in synchronisation with and at the required rate to meet the feed rate from the laser wire marking module. The use of back tensioning on the rereeler ensures that wire is tensioned correctly at all times and ensures that the rereeler rapidly and smoothly ceases taking up the wire when the feed from the laser marking module stops, without incurring problems of the drum over-running and resultant bird-nesting of the wire. The system also incorporates a cable lay mechanism to ensure wire is rereeled on to the take up spool in a smooth and uniform manner.

Please note the following key features:

- Powered dereeler capable of dereeling at 120 m/min (400 ft./min) – nominal for the specified drum sizes
- Dereeling synchronised to the demand from the laser wire feed system
- Interlocked safety enclosure
- Quick release device provided for the rapid change of reels
- Adjustable spigot provided to locate in reel drive holes
- Provision for the discharging of static electricity (optional)
- Maximum wire/cable diameter: 5 mm (0.20 inch) nominal,
- Reel dimensions: Maximum outer diameter 393mm (16 inch)
- Maximum drum width 300 mm (12 inch)
- Minimum inner diameter 150 mm (6 inch)*
- Reel maximum weight: 20 Kg (44 lbs.)*
- Shaft size: 19 mm (3/4”) = minimum reel centre hole diameter, larger reel centre holes can be catered for with the addition of collars up to 37 mm (1.45”)

* Smaller inner diameter spools and reels of up to 25 kg can be used albeit at slightly reduced running speeds or accelerations of the marker unit

Please note the following:

The R500E requires power and compressed air services to function.

2.12.4 Wire tension monitor

An optional strain gauge tension monitor may be fitted to the cable handler for all Nova models. The strain gauge measures the absolute wire tension and compares it to a value held in the wire parameter files held on the *CAPRIS* PC control system so that each wire type processed may be individually monitored. In case of excess wire tension the system will be halted and an error message will be will be registered on the operator’s screen to indicate the fault.

2.12.5 Zebra Model 110Xi4 label printer

A Zebra label printer, Model 110xi4 can be supplied and integrated with the CAPRIS laser wire marker. This enables relevant information such as wire bundle number, wire length, ship number, term code, run path letter, name of printing program etc. to

be printed on a label along with a barcode for each wire produced or as otherwise required. The printer is able to accept and print any engineering data that is available through the networked CAPRIS PC.

2.12.6 Bar code reader for wire reel verification and traceability

A standard bar code reader can be supplied and connected to the *CAPRIS* system. This will enable the wire supplier's labels and bar codes on wire reels to be read and the data read from the bar code labels to be input to the *CAPRIS* system to verify that the correct wire has been set up on the marker. Additionally the manufacturer's lot numbers and other data may be recorded for traceability purposes and later tracking of wire lots.

The bar code reader may also be used for scanning in other data in bar code format such as job data for selecting work packages and setting up the wire marker for processing jobs.

2.13 Control System

CAPRIS wire markers are controlled by an industry standard Dell tower PC and uses our proprietary *CAPRIS* Nova Operator Interface which incorporates a very simple, easy to use operator control interface, based on Microsoft Windows. A 17 inch (43 cm) display is included; full touch screen control is available as an option.

The PC controls all functions of the wire marker. Once the wire parameters have been initialised for the various wire types at installation, the operator has no need to be involved in any set up procedures when processing a job as the PC automatically sets the required values for the wire transport system according to the wire to be processed, as well as ensuring that the correct information is marked on the wire at the desired spacing's. This leaves the operator maximum freedom to handle the processed wire.

As noted above, the system provides a cable wastage minimisation routine. Extensive diagnostics are built into the system so that in the event of a fault, the system will shut down and display an error message to the operator. In the event of a wire fault, e.g. a splice, or in the event of the system running out of wire, the laser marker will automatically remake the last segment following reloading of a new wire.

2.13.1 Start up

To start the system initially, the main switch on the power unit on the rear of the *CAPRIS* marker is turned on. This powers up the system controller, which undergoes a self-check and then requests the user to enter their password on the PC to enable

further operation. There are multiple levels of security typically covering operator, supervisor and maintenance engineering.

2.13.2 Operation

The complete system is operated via the PC control screen using simple to understand menus and 'icons' (symbolic function keys). Minimal input is required to execute operations, e.g. start up and close down of the system is by means of the start/stop, green/red Windows 'button' icons.

Normal operation and running of the system is by means of the "run job" mode. This allows operators to select a particular job from a database of jobs. All information pertaining to the running of a particular job is automatically selected by the system. The operator is not required to make any significant input subsequent to selection of the job.

Alternatively, manual control of the system is possible via the "single section" mode. This allows operators to manually select a wire type for processing, upon which the system will automatically set up the right processing parameters for that wire type. The operator manually enters the information relating to:

- the identity code to be printed
- the length of the wire to be processed
- the number of segments to be processed in the batch
- whether wires are to be processed as cut lengths or as a continuous filament with cut marks

2.13.3 Operating modes: running jobs - automated data handling

When running jobs from a job file the system can be operated in one of two data handling modes: automated or manual handling mode. The normal method of operation is to use the automated mode to call up a job file generated from the customer's own database containing the wire production/job scheduling data. This enables job data to be handled automatically, minimising the operator involvement in set up.

Two modes of data processing and wire handling are provided:

2.13.3.1 Process by wire type:

This is the basic operating mode of the *CAPRIS* system for use in situations where wires are manually loaded in to the wire marking unit as would apply to the basic manually loaded system.

All wires of a particular type within a particular job are automatically grouped together in a single file. The file name is generated automatically as a function of the wire type and gauge, for instant recognition. The throughput of the machine in this mode is automatically maximised by minimising the number of wire set ups that the operator must undertake.

2.13.3.2 Process by connector/loom type:

This is the extended operating mode of the *CAPRIS* system which applies to automated systems when the marker is used in conjunction with the *CAPRIS* Auto Select and Load (ASL) system and a multi-station dereeler.

In this case the *CAPRIS* ASL provides high speed automatic change and set up of wires on the *CAPRIS* wire marking modules; with set up times of only seconds, wires can be produced in exactly the same order as they are listed in the customer database. This gives the customer total flexibility to order the database in the most convenient way, allowing wires to be processed rapidly and efficiently by connector, thus avoiding the need for subsequent sorting by hand. An audible signal or message window can be generated to indicate a break in the data, such as a change of connector.

2.13.4 Operating modes: processing single wires - manual data handling

Wires can also be run in 'manual' mode. This is particularly useful for remake of single wires or producing small batches of wires and cables on an as required basis. Here the operator needs only to input the data necessary for a single wire i.e.

- Wire type/identification
- Wire length
- Ident code (mark)
- Batch quantity
- Operating mode (cut length or continuous filament)

2.13.5 Wire parameter database

A database of wire types is maintained by the system. Each wire type has a set of unique parameters which determine the laser marking font (print size and orientation), processing speed, distance from the end of wire to the first mark (75 mm/3 inch default), mark spacing in the beginning and end zone of the wire (75 mm/3 inch default), mark space in the mid zone (75 mm/3 inch default), etc. to be used for the processing of that wire.

Spectrum engineers will initialise a range of wire parameter files at the time of installation and train the customer's engineers how to set up further files for later use. Wire parameters are automatically read and processed from the database on entry of the wire type, whether called up automatically as part of a job file, or entered by the operator under manual conditions. This means that the operator does not have to spend time setting up the system when changing wire types.

2.13.6 Sub system communications

Three RS232 ports are used to communicate with the laser, mask controller and cable feeder. The status of the sub systems is continually monitored. Additional ports are available for host connection and download of manufacturing data files.

2.13.7 Fault detection and recovery

Fault management is performed automatically by the system. In the event of a fault occurring during a job file run, the system generates a recovery file, which may be completed at the operator's convenience. The system detects all faults generated by the laser, mask controller and cable handler. Faults generated by the operator,

computer and network are also detected. Power and air supplies are continually monitored for failures.

Faults are displayed on the screen with an error code for reference and a text description with a suggested resolution. Continued operation is usually possible with minimum delay or machine down time. The system detects and signals the following fault or equipment conditions, among others.

- Abnormal line voltage conditions
- Low or no air pressure
- Equipment jam
- No wire
- Wire splice or knot
- End of wire on reel
- Mechanical and controller faults
- Laser faults

In recovering from a power failure, shut down or system failure that causes stoppage of the system, after restarting, the segment that was being processed must first be manually purged from the system; the system will then automatically replace the aborted segment.

In recovering from a failure in which the system control is retained, the failed segment will be automatically purged and the system will generate a replacement. Note, however, that in cases where the system shuts down on detection of a wire fault, the operator must visually inspect the system to determine whether the faulty wire can pass unhindered through the wire transporter e.g. butt wire splice, or whether the fault is too large for this, e.g. a knot, in which case the wire must be unclamped. In either case the operator must drive the faults section through the system using the manual drive button. After it has cleared the system the operator can then return the system to automatic operation via one input to the controller and the system will restart, automatically purging the tail end of the faulty wire before continuing and automatically remaking the segment.

2.13.8 System security

Access to this is controlled by a multi-level matrix of user id's and encrypted passwords, which prevent unauthorised users gaining 'entry' to the system.

The system recognises three levels of authority:

- The supervisor level is the senior level where password permissions may be set or updated.
- The operator level is a limited access level with sufficient access to perform routine daily operations. This ensures that individuals have access only to those areas that they require
- An additional access level is provided for (Spectrum) maintenance on the system

2.13.9 Network and communications

The system can receive data directly from a network via an Ethernet adaptor (available as standard on all PCs supplied) or other suitable PC communications interface e.g. RS232 serial data. A status file can be generated on the network detailing the run outcome of every section of wire along with the time and date of

completion. The wire lot/goods received number can be stored in this file to aid quality control traceability procedures.

Access to data can be:

- direct via a network interface e.g. virtual drive, or
- by introducing the data to the PC via CD-ROM/DVD or USB storage device
- an RS232 interface may be used to download production data directly into one of the spare serial ports on the PC (additional cost)
- customers can also use FTP (File Transfer Protocol) to transfer job file directly to a folder on the hard drive

The *CAPRIS* system software can be interfaced to the customer's system via a conversion program. This automatically generates an equivalent *CAPRIS* compatible job file in the target ASCII format from the customer's data. The *CAPRIS* system can therefore coexist transparently with the customer's current computing facilities with no major modifications. Alternatively data can be input via a floppy disc.

NOTE: Spectrum will advise of the required data format to enable the CAPRIS system to be run as a stand-alone system with data input from CD-ROM or USB flash drive in the right format. If the customer requires the system to be connected to a network to enable automatic download and processing of customer's job files a software engineer will develop a custom conversion program to facilitate the hook up and enable the connection and software; this is a chargeable service.

2.13.10 Operating system and applications software

All software has been written in Visual Basic .Net to support the latest version of Microsoft's Windows operating system. This includes all supporting libraries for the communication and display interfaces. Modification to the standard operating system and applications software will be upwardly compatible with subsequent releases. Modular concepts and software design techniques are used to ensure both high quality and ease of maintenance.

Note that a continuous operational log is maintained automatically by the system. This gives a full history of any major errors found. A manual service log is also kept as on line documentation of any routine maintenance carried out.

2.13.11 Help screens

"Help" windows exist for each detailed screen. These are accessed via common "Help!" buttons placed on the forms.

2.13.12 System reports

The system can provide the capability of viewing or printing system reports including the following:

2.12.2.1 Daily material usage

- A chronological summary of wire processed on the system each day. The report includes completed processed wire and wasted or discarded wire. The report date is operator selectable from a menu screen.

2.12.2.2 Overall material usage

- An inclusive summary of daily material usage on the system. The operator is able to select the start and end date for the report from a menu screen. The report is sorted and displays material usage by wire type as well as an inclusive total of all material processed.

2.12.2.3 Daily errors

- A chronological summary of all system errors that occur each day. The report includes an error code, brief error description, time of occurrence, system down time, and laser shot count. The report date is operator selectable from a menu screen.

2.12.2.4 Overall errors

- An inclusive summary of daily error reports that occur on the system. The report includes the error code, brief error description, and total number of occurrences. The operator is able to select the start and end date for the report from the system menu. The report is sorted by error code.

2.12.2.5 Daily events

- A chronological summary of all system activity, from the time of first login, for each day the system is run. The report date is operator selectable from a menu screen.

2.12.2.6 Job history

- A chronological history of a production job file. The report includes number of wires completed (by wire type), amount of wire completed (by wire type), amount of wire wasted/rejected (by wire type), set-up time, total job time, actual run time for the job, and average system throughput in feet per minute.

2.12.2.7 Wire definition

- a listing of wire definitions for all wire types stored in the systems The operator has the option of printing all wire definitions, or selecting a specific wire type from a menu screen.

2.12.2.8 Dereeler set up

- indicates the wire type loaded on each dereeler station on a multi-station dereeler (where incorporated in a system).

2.12.2.9 Event definition

- A list of all event codes and associated descriptions defined in the system.

2.12.2.10 Error definition

- A list of all error codes and associated descriptions defined in the system, sorted by code.

2.13.13 Wire end destination code software

Connector/pin data: This enables wire end destination data to be handled by the *CAPRIS* wire marking system. This allows separate wire end destination codes to be printed directly on to the 'A' and 'B' ends of the wire, in addition to the wire identity code normally printed down the length of the wire.

One or more destination codes will be printed at either end of the wire, allowing operatives using processed wire to make up the harnesses to directly identify connector/pin numbers, rather than having to rely on a paper or other system to identify the destination information from the wire identity code/part number. This provides significant labour savings in terminating wires.

3. CAPRIS MARK QUALITY

3.1 General

It is important that any wire marker provides maximum mark quality across its full operating range. All *CAPRIS* systems have been developed to offer optimum mark quality for all wire types. In particular, mark contrast or darkness is a function of applied laser power density at the wire surface. *CAPRIS* products are designed to provide constant power levels, regardless of operating conditions.

To achieve the required mark quality, *CAPRIS* systems comply precisely with international documents on wire marking, including:

- Society of Automotive Engineers - (SAE has now largely taken over responsibility for many ex US Military specifications and standards).
    - AIR 5468A - UV Lasers for Wire Marking (January 2006)
    - ARP5607A - Legibility of Print on Aerospace Wires (Nov 2005)
    - AS5649 Wire and cable marking process, UV laser
- ASD
    - prEN3475 Part 706 – Laser Markability
    - EN4650 Wire and cable marking process, UV laser

3.2 Specific wire types

CAPRIS wire markers employ the proven UV laser wire marking process developed by Spectrum Technologies for the aerospace industry. UV laser wire marking is now the international industry standard for marking aerospace wires and the wires most commonly used in present airframe manufacture and maintenance are specified by the airframe manufacturers to be UV laser markable.

Wire types that can be laser marked to give a high or acceptable contrast mark include:

3.2.1 PTFE tape-wrapped wire

UV laser markable composite PTFE/polyimide wire constructions are widely used in Europe and North America, for both military and commercial aircraft. Good mark contrasts, of 58-65%, are achievable on current UV laser markable stock.

Relevant specifications include:

Airbus DK, DM, DR and AD
Boeing Commercial Airplane Group BMS13-60
Boeing Long Beach DMS2426 rev. C
MIL-W-22759/80-92
McDonnell Douglas 5MD1
Pan Avia PAN 6411, 6412, 6417
Eurofighter J61.011, JN 1026

3.2.2 ETFE and XL-ETFE extrusions

ETFE is frequently used as wire insulation, either in its natural state or as cross-linked (XL-ETFE) for improved physical properties. In general, XL-ETFE wire gives more consistent high contrast results (>70%) than non-cross linked materials. Extensive UV laser marking trials have been carried out on these wires produced by a range of suppliers.

Relevant specifications include

MIL-W-22759/16, 17, 18	non-cross-linked ETFE
MIL-W-22759/32-35,41-46, 51	XL-ETFE
PAN 6843, 6844, 6845	
Eurofighter JN 1087	
Boeing Commercial Airplane Group BMS13-48	XL-ETFE
Boeing Commercial Airplane Group, Douglas Products Division BXS7008	XL-ETFE

3.2.3 PTFE extrusions

This wire construction is less frequently used in aerospace wiring, but may be UV laser marked and is available from several suppliers. However, these wires have not yet been specified to the same high standard for laser markability as, for example, ETFE extrusions. Mark contrasts of around 50% are achievable on standard product subject to testing and vendor selection.

Relevant standards include MIL-W-22759/9-12, PAN 6429.

3.2.4 Test samples.

If required Spectrum Technologies will be pleased to process samples of any wire and to measure the mark contrast and give a formal report and comment and advise on the mark quality. Testing will be undertaken according to BS EN 3475 Part 706 laser markability, or other relevant specification.

4. GENERAL

4.1 Hardware

Each piece of floor mounted equipment has at least 12.5 cm (5 inches) floor clearance at both front and rear of the unit. Adjustable levelling devices are supplied with each piece of floor mounted equipment. The wire marking system requires no more than 2.4 m (94 inches) of headroom in its operational configuration.

4.2 Applicable Specifications

Please note the following main standards which are applied to the design and build of the *CAPRIS* products.

a) Code of Federal Regulations (CFR) Title 21, Chapter 1, sub chapter J, US Food and Drug Administration, Laser Product Performance Standard.

b) BS EN 60825-1:2007 Safety of laser products – classification

c) BS EN 60825-4:2006 Safety of laser products – laser guards

d) BS EN 60204-1:2006 Safety of Machinery – Electrical equipment of machines

e) IEE Regulations covering the electrical system.

f) NFPA79: Electrical Standard for Industry Machinery

g) EC Directives
- 98/37/EC - Machinery Directive
- 2004/108/EC - EMC Directive
- 2006/95/EC - Low Voltage Directive

h) FCC rules CFR 47 Part 15 Limit A and part 18

i) Machinery safety
- BS EN ISO 12100-1:2003 Safety of machinery – General principles of design
- BS EN ISO 12100-2:2003 Safety of machinery – Technical principles
- BS EN ISO 13857:2008 Safety of Machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs

4.3 Acceptance

A previously agreed programme of acceptance tests will be undertaken on all equipment at Spectrum Technologies site before delivery to the customer; the customer is welcome to witness this. Subsequent to installation and commissioning of the equipment at the customer's factory, Spectrum engineers will carry out the final acceptance tests to verify that the system meets the required specification.

4.4 Training

A full course of training both for operators and maintenance personnel is provided at installation. Due to the simplicity of the operation and maintenance of these units, the training of personnel can normally be accomplished in a period of two days. However, additional training can be provided on request.

4.4.1 Level 1 Training

This covers full training of operators and basic training of maintenance personnel to enable them to undertake operation and basic routine maintenance of the equipment during the warranty period and under any subsequent maintenance contract. In addition to the basic training on the system it includes an in depth training session on optical system maintenance. This training is provided at installation and is included within the basic prices of the equipment supplied.

4.4.2 Level 2 Training

This is an in depth maintenance training course that enables customers own maintenance engineers to take on virtually all maintenance of the system independent of Spectrum. This training is a chargeable extra and is most often arranged sometime after the initial installation.

4.5 Documentation

A full set of documentation covering the operation and maintenance of systems will be provided, including all necessary drawings, programming and software documentation. All documentation provided will depict the final configuration of equipment at the time of delivery (as built). Documentation is provided in triplicate.

4.6 Warranty

A full one year onsite warranty covering both labour and parts is provided.

4.7 Product support

Spectrum Technologies philosophy on product support is as follows:

1. To design and build reliable products that requires the minimum level of maintenance and provides customers with the maximum level of uptime.

2. To make maintenance tasks simple and straightforward to accomplish and to train customer maintenance engineers to be able to carry out all routine maintenance activities.

3. To support equipment in the field by means of maintenance contracts. If required by the customer, to ensure that equipment is operating correctly and at optimum levels

4. To support customer's in house maintenance engineers by means of a 'customer hot line' such that in the event that customers have a maintenance problem that they are unable to fix themselves, they can contact Spectrum engineers by fax/phone/email for immediate assistance. Our engineers can then offer suggestions on how to proceed with a repair.

   Additionally the NOVA systems are designed with **Remote Assistance Capability** which can be used by the Customer to invite Spectrum engineers to connect to their computer for help. After connecting, the Spectrum engineer can view the remote computer screen at the same time as the customer to discuss the issues, run diagnostic tests and update software.

5 To provide a rapid call out service to repair equipment under warranty or maintenance contract where the customer's maintenance engineer has been unable to resolve a problem, even through use of the customer hot service.

6 After sales service will be carried out by Spectrum's fully accredited service agent.

Spectrum Technologies coordinates full product support on its products from its UK facility, with the aid of a network of fully trained service agents specifically chosen to support its export customers.

In North America service is provided directly through Spectrum Technologies Inc., a wholly owned subsidiary of Spectrum Technologies PLC, based in Phoenix.

Spectrum maintains dedicated teams of service engineers located in the UK and USA for servicing and supporting customers in Europe and North America. In other regions Spectrum's local agents and distributors are trained to provide local service to customers. A full list of sales and service agents can be found on our website at http://www.spectrumtech.com/contact/product_support.htm

DEFINITIONS

For the purposes of this specification the following terms and definitions apply.

Cable: Electrical cable, unless noted as a fibre optic cable. Two or more insulated conductors, solid or stranded, contained in a common covering, or two or more insulated conductors twisted or moulded together without common covering, or one insulated conductor with a metallic covering shield or outer conductor.

Contrast: A measurement relating to the difference in luminance of the mark and its associated background according to a precise formula. Minimum contrast levels are specified for marked wire to aid legibility.

Damage: For the purpose of this document, with reference to wire and cable, damage is defined as an unacceptable reduction in the mechanical or electrical properties of the insulation, i.e. specifically a measurable reduction in the performance of the wire or cable that is outside of its defined specification or is otherwise unacceptable.

Fibre Optic Cable: A cable that is designed to transmit light waves between a light transmission source and a receiver. In signal applications, the transmitter and receiver include devices that are used to convert between optical and electronic pulses. Typical cables include a glass or plastic core, a layer of cladding having a lower refractive index to refract or totally reflect light inward at the core/cladding boundary, a buffer, strength members and jacketing to protect the inner cable from environmental damage.

Fluence: The energy density, measured in J cm^{-2} (Joules per square cm) of a single pulse of the laser beam, which, for the purposes of this document, is at the surface of the wire insulation or cable jacket.

Font: The defining shape and style of a character set for printing or marking.

Gauge: The wire size specified for a wire in a wire harness assembly by the wire harness assembly drawing.

Harmonic generation: The use of non-linear optical processes to change the wavelength of a laser by frequency conversion. This enables the output of an infrared laser to be converted to shorter wavelengths. In the case of Nd lasers these results in a frequency doubled output at 532 nm in the green and a frequency tripled output at 355nm in the UV, which is used for wire marking. The process is not 100% efficient and appropriate precautions must be used in the design and operation of such lasers to ensure that the residual unconverted infrared laser radiation reaching the wire surface is kept to a safe level.

Harness: An assembly of any number of wires, electrical/optical cables and/or groups and their terminations which is designed and fabricated so as to allow for installation and removal as a unit. A harness may be an open harness or a protected harness.

Infrared: **(**Abbreviation IR) Electromagnetic radiation in the wavelength range from approximately 700 nm to in excess of 10,000 nm.

Jacket: An outer protective covering for a cable.

Laser: Laser is an acronym for Light Amplification by the Stimulated Emission of Radiation. Lasers are a source of intense monochromatic light in the ultraviolet, visible or infrared region of the spectrum. The "active" or lasing medium may be a solid, liquid or gas. The laser beam is generated by energizing the active medium using an external power source, which is most commonly electrical or optical.

Legibility: Properties of a mark that enable it to be easily and correctly read.

Mark: A meaningful alphanumeric or machine readable mark applied to the surface of a wire or cable jacket.

Neodymium: (Abbreviation Nd) Neodymium is an elemental metal that forms the active laser material in the most common type of solid state laser. The neodymium is held in an optically transparent solid "host" material, and is energized by optical input, either from a flash lamp or from the optical output from a diode laser. The host material does not play a direct role, but can slightly influence the laser wavelength. Typical host materials are specialized crystal materials, such as Yttrium Aluminium Garnet (YAG) and Yttrium Lithium Fluoride (YLF). These lasers are commonly referred to as Nd: YAG or Nd: YLF respectively. The primary wavelength of Nd solid state lasers is in the infrared (IR) at a wavelength of approximately 1064 nm. The IR output of such lasers can be conveniently reduced to lower wavelengths suitable for wire marking by use of harmonic generation.

Ultraviolet: (Abbreviation UV) Electromagnetic radiation in the wavelength range from approximately 200 nm to 400 nm.

UV laser: A laser that produces a beam of radiation in the UV range.

Wavelength: (λ) Wavelength is measured in nanometres, nm. 1nm = 10^{-9} m. $\lambda = c/f$ where c is the velocity of light and f is the frequency.

Wire: A single metallic conductor of solid, stranded or tinsel construction, designed to carry current in an electric circuit, but not having a metallic covering, sheath or shield. For the purpose of this specification, "wire" refers to "insulated electric wire."

Wire code: The wire circuit identification number or code assigned to a specific wire in a wire harness assembly and marked on the insulation surface.