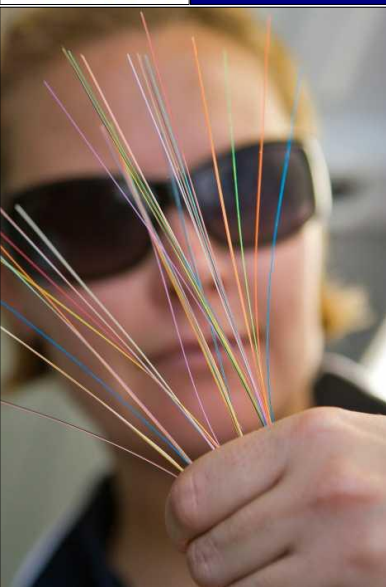




Proton Products IntelliSENS® Technical Bulletin

On-line Excess Fibre Length (EFL) measurement and Control System

For jelly-filled, loose-tube optical fibre buffering lines



Requirements and processing for Excess Fibre Length (EFL)

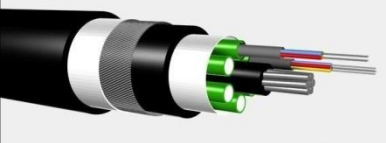
A loose-tube optical fibre bundle typically comprises between 2 to 24 colour coded optical fibres. During the fibre buffering extrusion process, the fibres are laid as a helix in a jelly-filled, loose tube. To ensure that the fibres can move freely, the fibres must be longer than the tube by the Excess Fibre Length (EFL). Jelly-filled loose tubes typically must achieve an EFL of 0.1 to 0.25%.

Since the loose-tubes are subsequently processed into cables, the free-movement of the fibres is essential to accommodate both cable bending and the different thermal expansion coefficients of the cable sheath/outer coating, strength member and buffer tubes. Free-movement of the fibres relative to all the surrounding components avoids fibre deformation or breakage.

The most technically challenging element in loose-tube production is controlling and maintaining the EFL in relation to the tube length.

Numerous patents have been issued to manufacturers of cables and cable machinery on on-line methods of controlling the EFL. The factors in the buffering process that affect the EFL are:

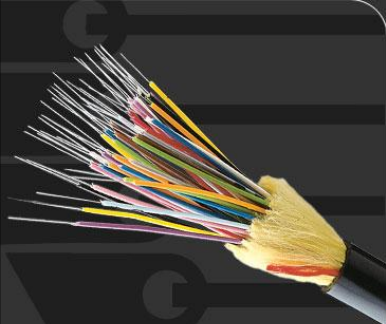
- Fibre pay-off tension
- Jelly viscosity
- Cooling trough water temperatures
- Tube quenching point
- Mid-span capstan position
- Mid-span capstan to caterpillar-capstan tube tension
- Caterpillar-capstan to take-up tube tension
- Extrusion tool design
- Production line speed
- Loose-tube polymer crystallisation kinetics



With so many contributing factors, the EFL cannot be guaranteed to always fall within specification, thus not even a single manufacturer of optical fibre cable relies on this combination of parameters to control EFL. Current industry-standard practice is to sample a 4m length of loose-tube from each completed reel and measure the EFL of each fibre in the bundle; if the EFL falls out of specification then the whole reel is scrapped. Despite modern process control and ever-improving processing lines, in many cases manufacturers still rely on the experience and skill of line operators to hold the EFL within required tolerances.

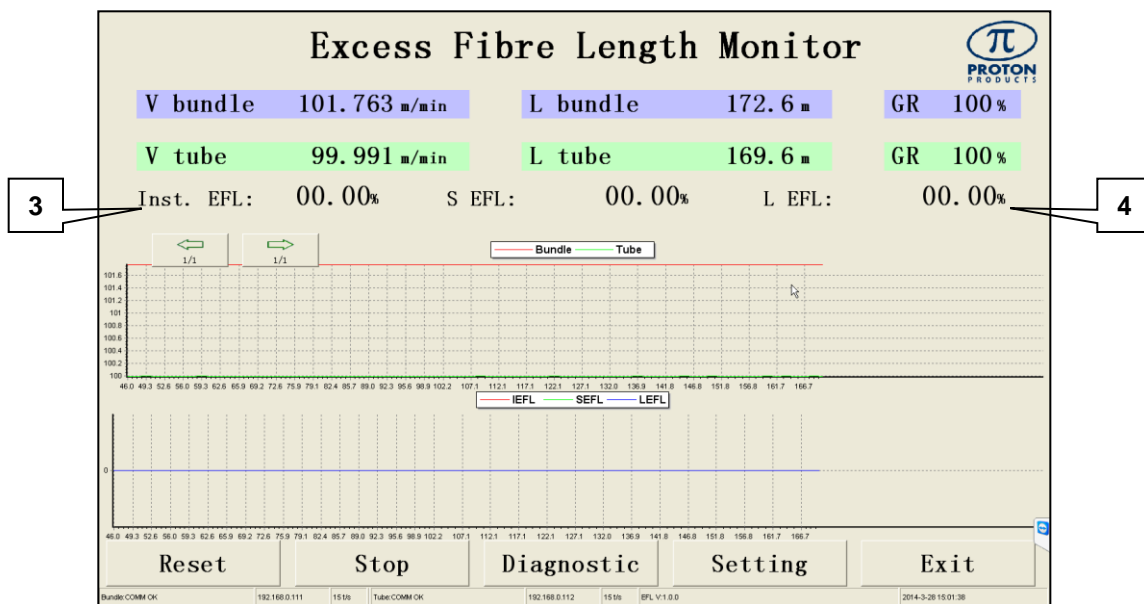
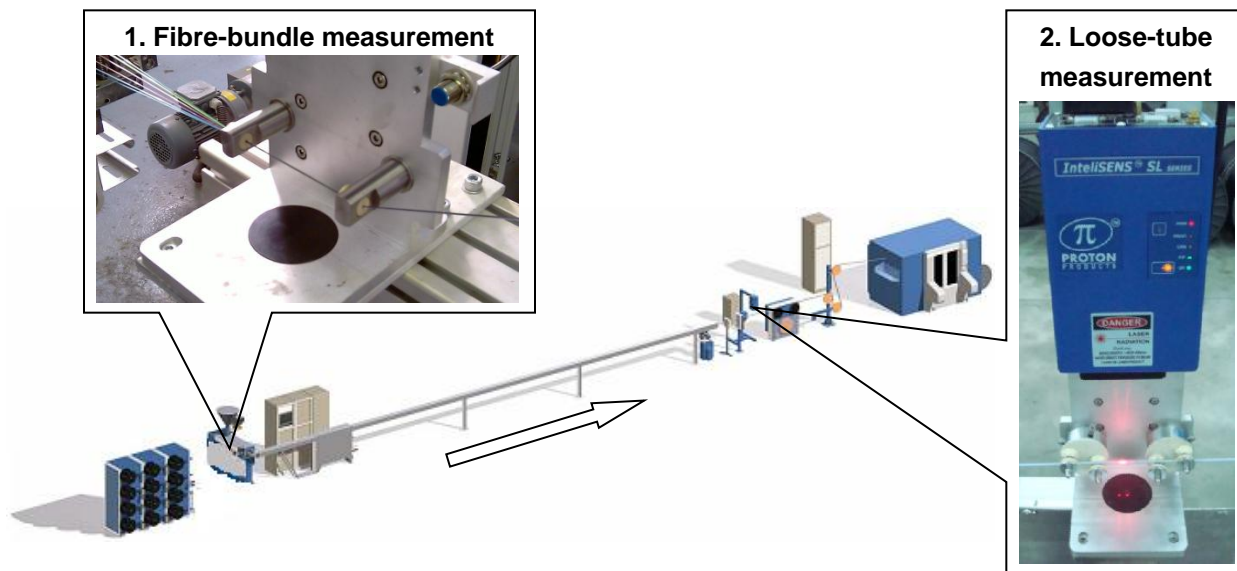
Proton Products IntelliSENS® on-line, real-time EFL measurement

Proton Products IntelliSENS® laser Doppler speed and length measurement technology now provides on-line, real-time EFL measurement. The fibre-bundle and loose-tube speeds and lengths are measured on-line to an accuracy of within 0.02% and then the EFL is precisely calculated in real-time.



**MEASURE EXCESS FIBRE LENGTH ON-LINE AND IN
REAL-TIME TO WITHIN 0.02% ABSOLUTE
PRECISION**

Proton Products IntelliSENS® Inline Excess Fibre Length Measurement System

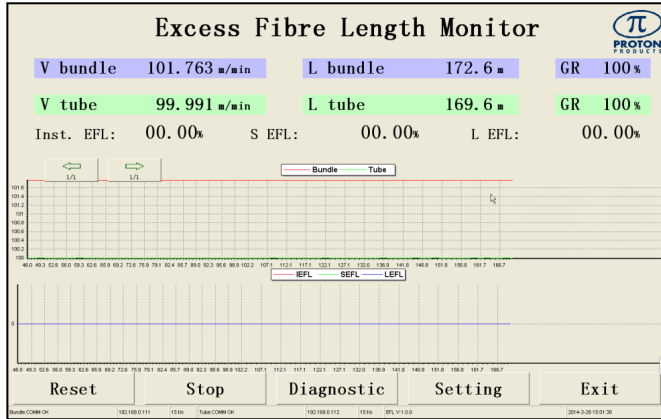


- Fibre-bundle measurement:** A SL1525 laser Doppler sensor located just prior to the tube-extruder measures the speed and length of the fibre-bundle (between 2 to 24 individual fibres) to an accuracy of $\pm 0.02\%$.
- Loose-tube measurement:** A SL1525 laser Doppler sensor located just prior to the haul-off capstan measures the speed and length of the loose-tube to an accuracy of $\pm 0.02\%$.
- Real-time, instantaneous EFL computation:** Custom-written software running on an industrial-PC computes the real-time, instantaneous EFL from the difference between the fibre-bundle and loose-tube speeds. The instantaneous EFL reflects real-time changes in the line speed and tension due to the interaction between the fibre pay-off and haul-off capstan.
- Average EFL computation:** the average EFL is computed from the difference between the fibre-bundle and loose-tube cumulative lengths. Both "long" and "short" average EFLs are available to reflect the average EFL over corresponding lengths. The average EFL matches off-line sample measurements.

Proton Products IntelliSENS® EFL System Ordering information



Bundle: 1 x SL1525 with PHA2 mounting console



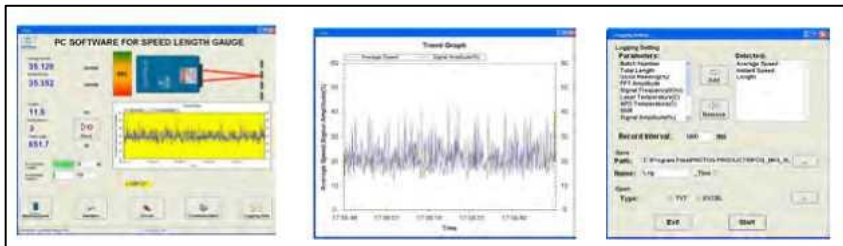
Industrial-PC with custom EFL software



Tube: 1 x SL1525 with PHA2 mounting console



2x PSU-BOB Power Supply and Breakout Box one for each SL1525 Laser System



Optional PCiS-SL software for easy, PC-based configuration of SL1525 gauges

Proton Products IntelliSENS® EFL System Advantages

- Measurement rate:** Once every 40 microseconds
- Repeatability:** 0.02% for speed, length and EFL
- EFL Resolution:** 0.01%
- Accuracy:** Certified to UKAS traceable standards
- Non-contact:** No slip, no wear and no calibration requirement
- All fibre bundles:** Accommodates fibre bundles with 2 or more fibres
- No moving parts:** No wear, no drift and no maintenance requirement
- Simple operation:** No requirements for operator settings
- Time saving:** Avoids off-line, destructive-measurement for EFL
- Reduced wastage:** Avoids scrapping of fibre or loose-tube
- Final tube length:** Also provides accurate final tube length measurement, replacing inaccurate mechanical length counters
- Return on Investment:** Within a few weeks or months

InteliSENS® EFL System component specifications / descriptions

InteliSENS® SL1525 laser Doppler speed and length gauge specifications			
Minimum speed	0.1 m/min		
Maximum speed	3000 m/min		
Nominal stand-off distance	150 mm		
Depth of field	25 mm		
Repeatability	0.02%		
Maximum acceleration	>500 m/s ²		
Measurement rate	40 µs		
Ingress Protection rating	IP67		
Ambient temperature	5 - 45° C		
Dimensions (L x W x H)	230 x 130 x 75 mm		
Laser beam diameter	4 mm		
Laser classification	Class 3B (European Safety Norm EN60825-1:2001 compliant)		
Calibration	UKAS (United Kingdom Accreditation Service) traceable with EU-wide recognition through bilateral agreements		
Standard communications	RS-232	RS-422/485	Bluetooth
Optional communications	PROFIBUS	DeviceNET	Ethernet/IP
Logic inputs	Reset	Hold speed	Hold Length
Relay outputs	Length 1 exceeded	Length 2 exceeded	Gauge OK
Analogue output	0 – 10V; end-user configurable scaling; updated every 40 µs		
Pulse outputs	3x pulse outputs; end-user configurable; 5 - 24V output; 1MHz maximum frequency; updated every 40 µs		

PSU-BOB-SL power supply and breakout box specifications	
Power supply voltage	110 – 240 VAC
Power supply frequency	50 – 60 Hz
Laser safety interlock	Key switch for EN60825-1:2001 compliance

PHA2 precision mounting console (fibre-bundle end, located just prior to the extruder)
Fitted with a specially-developed conical needle-tube guide for guiding a up to 12 optical fibres

PHA2 precision mounting console (loose-tube end, located just prior to the haul-off caterpillar)
Fitted with polished ceramic self-centering guides for guiding the loose-tube

HST2 Height Stands
Height-adjustable floor stands for mounting the PHA2 precision mounting consoles

Industrial-PC with EFL software
19 inch touch screen colour LCD display
Real-time display of fibre-bundle and loose-tube lengths and speeds
Real-time display of instantaneous, short-averaged and long-averaged EFL with graphical charting

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