

LineMaster Extrusion Control

Product Guide



OVERVIEW

The modular design of LineMaster™ allows easy selection of the components...



HOW IT WORKS

Start-up in automatic control mode from the beginning...



PRODUCT INFORMATION

View our full technical specification and payback...



CONTACT

Find out your local contacts or where your regional head office is located.

**ENHANCE
PRODUCT
CONSISTENCY
AND SAVE ON
RAW MATERIALS**

MAGUIRE®
Intelligent Simplicity

LineMaster Extrusion Control

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Maguire Products offers one of the
most comprehensive warranties in
the plastics industry.

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The most popular gravimetric
blenders worldwide.

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OVERVIEW



Functions and Benefits

REDUCTION IN MATERIALS CONSUMPTION

LineMaster automatically regulates the drive speeds of an extrusion line to ensure the correct amount of material is used, and excess waste is eliminated. Giving an average 4% material savings based on hundreds of installations.



IMPROVED PRODUCT CONSISTENCY AND QUALITY

With automatic control and regulation, the **LineMaster** system regulates drive outputs ensuring that the actual output meets target by regulating the extruder drive or take-off drive to the target required – ***maintaining consistent product specification and quality.***

FASTER START-UP TIME

As soon an extrusion line is strung up, an operator can switch from manual start-up to automatic control and set the required output – ***without any need for further operator involvement, saving considerable time.***



REDUCE SCRAP LEVEL WITH FASTER START-UP TIME

The amount of scrap and off spec product is dramatically reduced by quickly switching to automatic production mode.

SIMPLE AND EASY CONTROL FOR OPERATORS

Control options and product parameters are reduced to one key point of control – the operator simply enters the target required with no need to manage other process variables.



CHANGE JOBS QUICKLY

Switch quickly from one production order to another with direct online control – ***increasing production time and profits.***

DOCUMENTATION OF PRODUCTION RUNS

LineMaster totalises lb/h or kg/h data – allowing users to track material usage, production output and plan job changeovers, assisting quality and cost control.



Maguire G2 software can be connected to **LineMaster** to generate reports on material consumption, while controlling performance and production lines remotely, for XC-1 and XC-2 applications and is an integral part of the XC-3 extrusion multi-layer line.

Core Components

The modular design of LineMaster™ allows easy selection of the components required for any type of extrusion line.

LIW Loss-in-Weight Hopper

The LIW Loss-in-Weight hopper is sized to suit the maximum possible output of a mono or co-extruded layer of a line. The range of LineMaster Loss-in-Weight hoppers cater to every application of free flowing material, pellets, granules or powder.

Each LineMaster hopper monitors the Loss-in-Weight of material as it flows into the extrusion line.



Magnetic retainers on hopper enclosure allow rapid access to LIW Hopper.



The hopper is suspended on a pair of highly accurate load cells, which are sized according to throughput.

Controllers

Each LIW incorporates a controller for the LineMaster. Key information is summarized on the display. The control on the LineMaster hopper monitors weight while reading and updating the throughput calculation every second in lb/h or kg/h. This basic information is provided to the system so actual product throughput or weight per length can be calculated and controlled.

XC-1 CONTROLLER



LIW Controller

XC-2 CONTROLLER



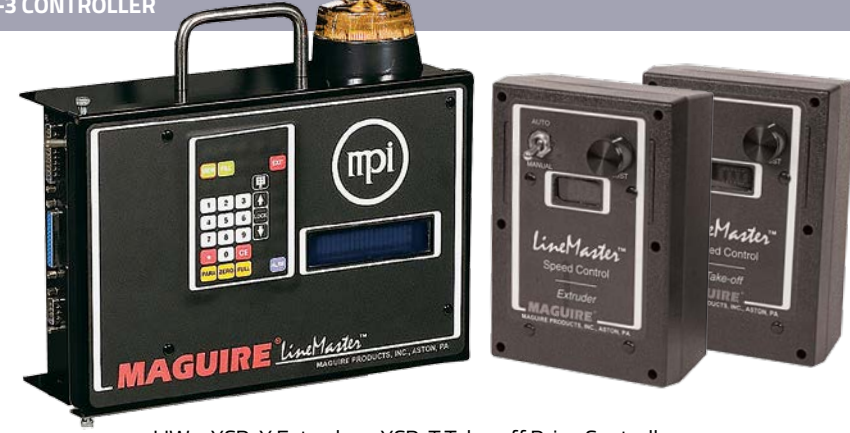
LIW + XCD-X Extruder Controllers

XC-2T CONTROLLER



LIW + XCD-T Take-off Drive Controllers

XC-3 CONTROLLER



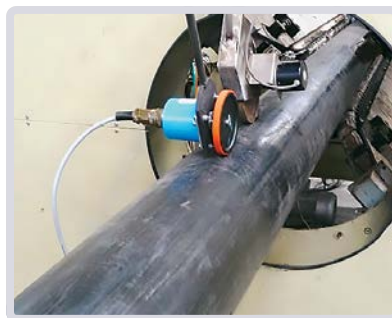
LIW + XCD-X Extruder + XCD-T Take-off Drive Controllers

Digital Encoder

A Digital Encoder with a 12 in./300 mm wheel is also supplied with XC-2X, XC-2T and XC-3 Drive Control packages where line speed needs to be determined.

The encoder is mounted either direct to a drive shaft on the nip roller or mounted with the wheel on a roller. This accurately monitors the line speed to calculate the weight per length and/or gauge of product.

The encoder cable (100 ft./30.4m) is supplied with connectors installed to communicate with the XCD Drive Interface Card.



**DIGITAL ENCODER INSTALLED ON
PIPE EXTRUSION LINE.**

**KEEP
CONTROL
OF MATERIAL
USAGE**

Options

A full range of optional components is available to suit your processing needs depending on the powder or granule application and how the system is installed.

SURGE HOPPERS / STUB TUBE ADAPTERS



Quick filling of the LIW Hopper is critical to ensure uniformity of process control. We recommend that at least half the LIW batch size is available above the LIW to ensure a quick refill. A surge hopper may be omitted if a sufficient reservoir of material is always contained in overhead lines feeding the LIW Hopper.

FMC FLOW MODERATOR CONES



These are different sized cones that fit into the LIW for use specifically with free flowing Powders such as PVC. These cones are important to ensure consistent flow from the Loss-in-Weight hopper into the extruder.

DRAIN PORTS



A range of optional Drain Ports can be mounted below the LIW hopper to allow quick evacuation of materials from the LIW for cleaning and material changes.

MXF STARVE FEEDERS



Starve feeding stops a twin screw extruder from being flooded with material – critical to performance of this type of line design. The Starve Feeder is controlled, instead of the extruder drive, regulating the weight/hour being supplied to the line.

LIW CONTROLLER REMOTE CABLE KITS



Cable kits of different lengths are available to remote-mount the Loss-in-Weight Controller.

MXF Starve Feeders are available with two throughput ranges –

MXF-1650: UP TO 750 LB/H (340 KG/H)

MXF-4894: UP TO 2,500 LB/H (1,130 KG/H)

HOW IT WORKS

Line Start-up

Start-up in automatic control mode from the beginning.

On a first time start-up of the process, the control system is placed into 'Manual' mode. The operator starts the line as normal. During this time the LIW Controller learns the rate of the material flow through the Loss-in-Weight hopper within 45 seconds. The line can then be switched to 'Automatic' control.

Throughout the whole production process, from ramping up the line, reaching target production and then ramp down, the Loss-in-Weight hopper is monitoring consumption of material. In 'Automatic' mode the system constantly compares **Actual** versus **Target**, and then adjusts the speed of the drive to maintain target set point.

It does this by monitoring throughput into the extruder every second. The system compares this actual data to target data. If there is a deviation, the system accumulates a weight error until it hits a trip point to make an adjustment to the voltage of the drive under control. The LineMaster system does this continuously, trimming the drive up or down to stay on target.

Control during the refill period is constantly maintained by intelligent dynamic algorithms in the software of the LineMaster control, maintaining the control before and after loading, to ensure line stability and consistency.



The accuracy of LineMaster is extremely consistent to within $\pm 0.5\%$ of the required target set point.

Line Corrections

During a production run there are many factors that cause a line to deviate from the Target output required. All of these make the process less consistent, harder to regulate automatically and use more energy.

Examples requiring line correction include:

Screen Packing

As contaminants build up on the screen of the extruder this slows output and increases melt pressure. Conversely, as screen packs are changed, melt pressure and output can change again, all of which cause product to vary from the target weight per length required.

Voltage Fluctuations

Over a given 24-hour period, power supplies can fluctuate to a plant affecting all drives and outputs, causing variable outputs on extrusion lines.

Melt Flow Temperature Fluctuations

Heating and cooling of screws and barrels can vary significantly due to many factors, including worn drives, which can cause sheer on materials leading to variations in output.

Worn Screws and Barrels

Over time, and depending on materials used and maintenance, screws and barrels can become worn – leading to variable outputs from an extruder.

Material Mix, Geometry and Density Changes

Changes in densities or blends of materials impact output consistency.



The LineMaster system helps to regulate fluctuations and stabilize end product to give a more consistent output.

Throughput Control – XC-1

Where to use XC-1 Throughput Control?

XC-1 is ideal for simply controlling the throughput of an extruder or starve feeder. Applications include simple lb/h or kg/h extruder control, where other downstream equipment is already automating the Take-off Control, for example online gauging or IBC (Internal Bubble Cooling) control.

Principal of Operation

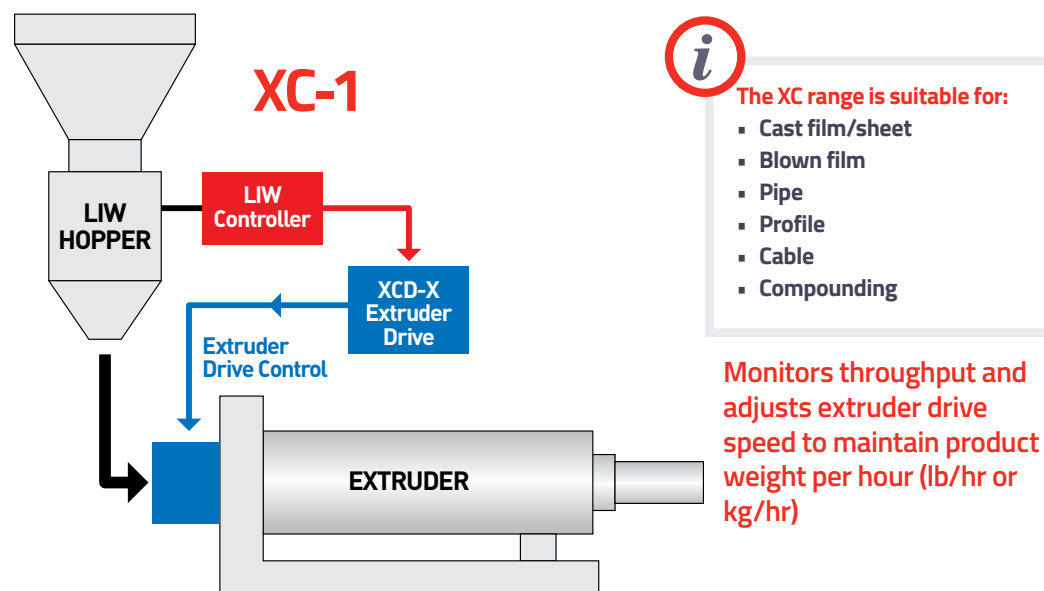
The XC-1 Extrusion Throughput Control System is designed to maintain a product's weight over time by monitoring the material consumption of the process through the LIW hopper on the throat of the extruder in weight per hour, and adjusts the extruder speed to maintain the desired throughput.

The actual throughput is compared to the desired target throughput. The LineMaster controller communicates to the Extruder Drive Control to adjust the voltage or reference signal to the extruder drive which will increase or decrease extruder RPM to maintain the desired throughput.



XC-1 adjusts extruder drive speed to maintain product weight per hour

- The LIW mounted on the throat of the extruder monitors the actual throughput (lb/h or kg/h) of the line.
- Target throughput is set on the LIW Controller and the operator then switches to 'Automatic' mode.
- LineMaster varies speed of the extruder or starve feeder to maintain the target throughput per hour when in 'Automatic' mode.
- The system maintains constant output of an extruder or starve feeder.
- LIW controller communicates — with the XCD-X Extruder Drive Speed Control, which adjusts the voltage or reference signal to the extruder drive. — This controls the speed of the extruder drive and adjusts automatically to maintain desired throughput.



Throughput Control – XC-2X

Where to use XC-2X Yield Control

XC-2X is ideal to control the output of an extruder or starve feeder. Typical application is to control weight per length (lb/ft, g/ft, g/m, kg/m) where other equipment, downstream, may already be automating the Take-off Control, for example, online gauging or IBC (Internal Bubble Cooling) control. Most mono extruders are run at, or near maximum output so control of the take-off is often preferable – **see XC-2T**.

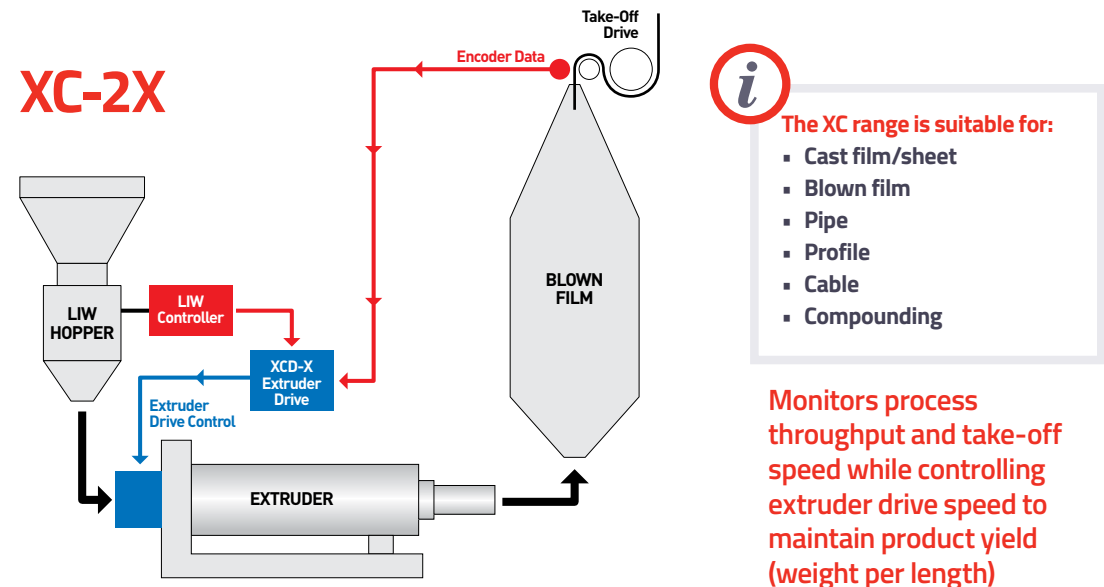
Principal of Operation

The XC-2X Extrusion Yield Control System is designed to maintain a product's weight per length (yield) by monitoring the material consumption of the process and collating consumption data with the line speed monitored by an encoder to provide actual product yield in grams or kilograms per meter. The actual yield is compared to a desired target yield. The LineMaster controller communicates to the Extruder Drive Speed Control to adjust the voltage or reference signal to the extruder drive which will increase or decrease extruder RPM with respect to the line speed to maintain the desired yield. A digital potentiometer replaces the existing rotary drive speed control on the extruder drive panel and communicates with the XCD-X Drive Speed Control which is mounted in or on the control cabinet and is connected to the LIW controller. If a PLC is utilized, LineMaster is configured to follow PLC signal to provide closed loop control.



Weight per length control via extruder drive

- The LIW mounted on the throat of the extruder provides throughput data in lb/h or kg/h.
- Line speed is monitored in meters/minute via the Digital Encoder mounted on any rotating shaft in the take-off drive.
- These two pieces of data are used to automatically calculate the actual product "yield" in lb/ft, g/ft, g/m, or kg/m.
- The actual yield is compared to the target set upon start up of the LIW Control.
- The LIW controller communicates — to the XCD-X Extruder Drive Speed Control which adjusts the voltage or reference signal to the extruder drive —.
- Product weight per length (yield) is maintained automatically, adjusting the speed of the line up or down in relation to extruder drive.
- If the speed of the take-off drive is manually increased or decreased, the LineMaster control will automatically adjust the extruder speed to maintain constant weight per length.
- The take-off drive is manually controlled when using the XC-2X.



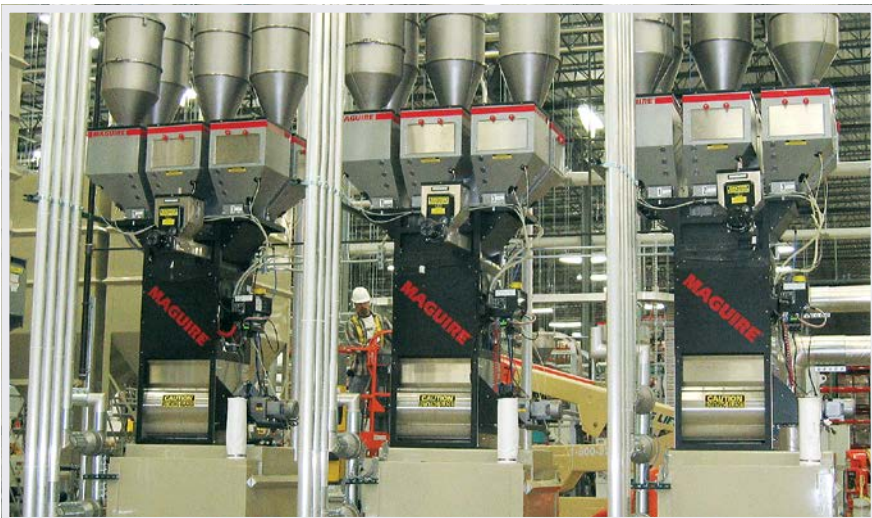
Throughput Control – XC-2T

Where to use XC-2T Yield Control?

XC-2T is most commonly used for mono layer extrusion lines. The line speed is determined by the digital encoder mounted on any rotating shaft of the take-off equipment. Using the throughput information (lb/h or kg/h) from the extruder, the actual weight per length of the extruded product is determined. For example $\text{kg/h} \div \text{m/min} = \text{g/m}$. The control of the take-off drive, which often has a much finer resolution than that of an extrusion drive, is then maintained automatically, adjusting the speed of the line up or down in relation to extrusion output.

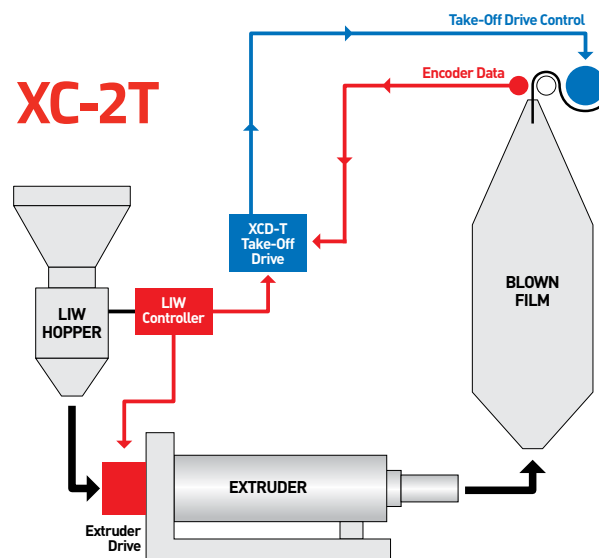
Principal of Operation

The LIW controller communicates to the Take-off Drive Speed Control to adjust the voltage or reference signal to the Take-off drive which will increase or decrease line speed with respect to the extruder speed to maintain the desired yield. A digital potentiometer replaces the existing rotary drive speed control on the take-off drive panel and communicates with the XCD-T Take-off Speed Control which is mounted in or on the control cabinet and is connected to the LIW controller. If a PLC is utilized, LineMaster™ is configured to follow PLC signal to provide closed loop control.



Weight per length control via take-off drive

- Primary difference is that the XC-2T controls the speed of the take-off drive.
- Throughput of the LIW on the throat of the extruder is monitored in lb/h or kg/h.
- Line speed is monitored in meters/minute via the digital encoder mounted on the any rotating shaft in the take-off drive.
- These two pieces of data are used to automatically calculate the actual product “yield” in lb/ft, g/ft, g/m, or kg/m.
- The actual yield is compared to the target set upon start up of the LIW Control.
- The LIW controller communicates ——— to the XCD-T Take-off Drive Speed Control, which adjusts the voltage or reference signal to the take-off drive ———.
- Product’s weight per length (yield) is maintained automatically, adjusting the speed of the line up or down in relation to take-off drive.
- The Extrusion Drive is manually controlled using the XC-2T.
- If the speed of the Extrusion Drive is manually increased or decreased, the LineMaster control will automatically adjust the take-off speed to maintain constant weight per length.



The XC range is suitable for:

- Cast film/sheet
- Blown film
- Pipe
- Compounding
- Cable
- Profile

Provides control of haul-off to maintain weight per length via feedback from encoder mounted on downstream haul-off

Throughput Control – XC-3

Where to use XC-3 Yield Control?

XC-3 can be used on mono extrusion lines where a user wishes to automatically control both the extruder output and the take-off line speed. For multi-layer lines, XC-3 operates on the main layer, the master layer of the co-extrusion line and controls both the speed of the extruder drive and speed of the take-off drive.

Principal of Operation

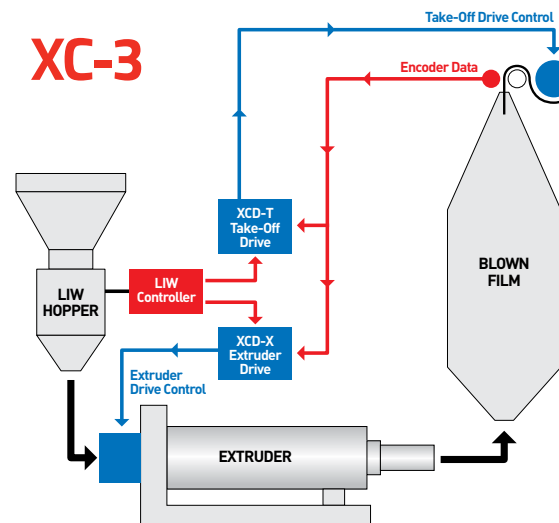
The XC-3 Extrusion Yield Control System is designed to maintain a product's weight per length by monitoring the material consumption of the process and collating the consumption data with the line speed monitored

by an encoder to provide a calculated actual product yield in grams or kilograms per meter. Comparing actual yield to the desired target yield, the LineMaster controller communicates to the Extruder Drive Speed Control which adjusts the voltage or reference signal to the extruder drive to increase or decrease with respect to the line speed and maintain the desired yield. Digital potentiometers replace the existing rotary drive speed control on the take-off drive and extruder drive. The two drive controllers communicate with one another to provide a synchronous ramp of all drives as directed by the LineMaster touch screen computer. If a PLC is utilized, LineMaster is configured to follow PLC signal to provide closed loop control.



XC-3 Weight per length control of both extruder and take-off drives

- The system includes a LIW Hopper, a controller with operator interface, extruder drive speed control package for each extruder and a Take-off/Line Speed Control package with digital encoder.
- The LineMaster XC-LMC computer with touch screen (optional) is required for simultaneous control of both extruder drive speed and line speed.
- Two or more Extruder Drive Controllers communicate  to each other to synchronize the ramp up and down of all drives as directed by the LineMaster XC-LMC computer.
- The XC-3 is designed to maintain product weight per length (yield) or Calculated Gauge.
- Material throughput of the LIW hoppers, mounted on the throat of each extruder, is monitored in Lb/h or kg/h.
- This data is combined with the line speed, provided by the encoder  mounted on a rotating shaft of the take-off.
- Actual product yield or gauge is calculated.
- The actual yield is compared to the desired target yield of the product entered on the LIW controller.
- The LIW controller communicates to the XCD-X Extruder Drive and XCD-T Take-off Drive Speed Controllers  to adjust the voltage or reference signal to each extruder drive, controlling increase or decrease of speed in relation to the line speed to maintain  desired target yield.



- **Monitors throughput and line speed**
- **Adjusts extruder and line speed to maintain product weight per length**
- **Requires XC-C LineMaster computer controller and is typically used for multi-layer applications**

PRODUCT INFO



Model Summaries

XC DRIVE CONTROL PACKAGES

Model	Drive Controlled		Units of Control							
	Extruder Drive	Take-off Drive	lb/h	kg/h	lb/ft	g/ft	kg/m	g/m	Mil.	Micron
Mono Layer Extrusion Lines										
XC-1	•		•	•						
XC-2X	•				•	•	•	•		
XC-2T		•			•	•	•	•		
XC-3X	•	•			•	•	•	•	•	•
Co-Extrusion Lines										
Main/Master Layer										
XC-3	•	•			•	•	•	•		•
Side/Slave Layers										
XC-1 - Per Layer	•		•	•						

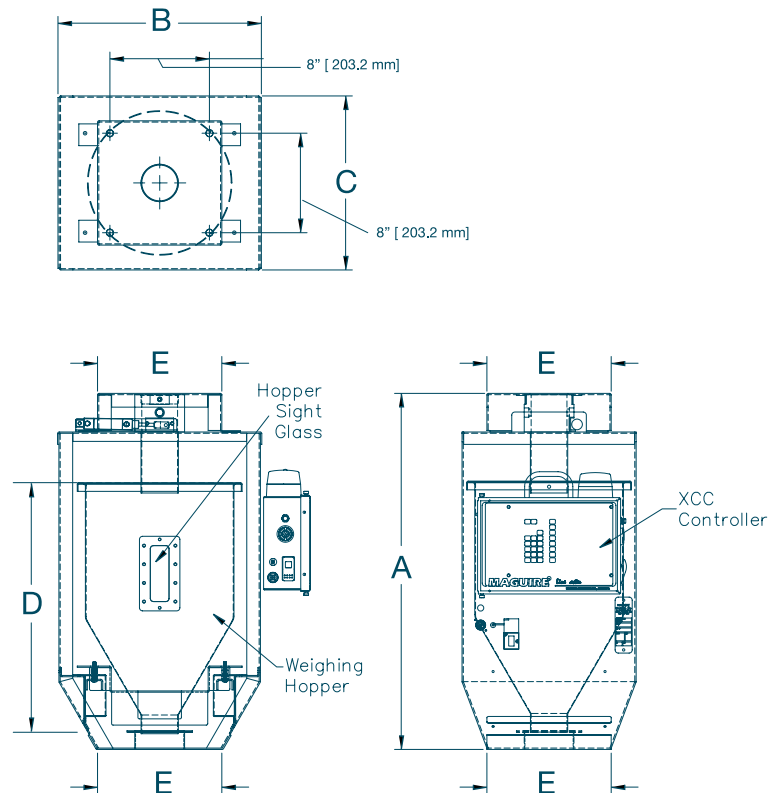
LINEMASTER OPTIONS

Model	Surge Hoppers	Stub Tube Adapters	Flow Moderator Cones	Drain Ports	Controller Cable Kit	MXF Starve Feeders	XC Software
LIW-05W	•	•	•	•	•	•	•
LIW-10W	•	•	•	•	•	•	•
LIW-25W	•	•	•	•	•	•	•
LIW-40W	•	•	•	•	•	•	•

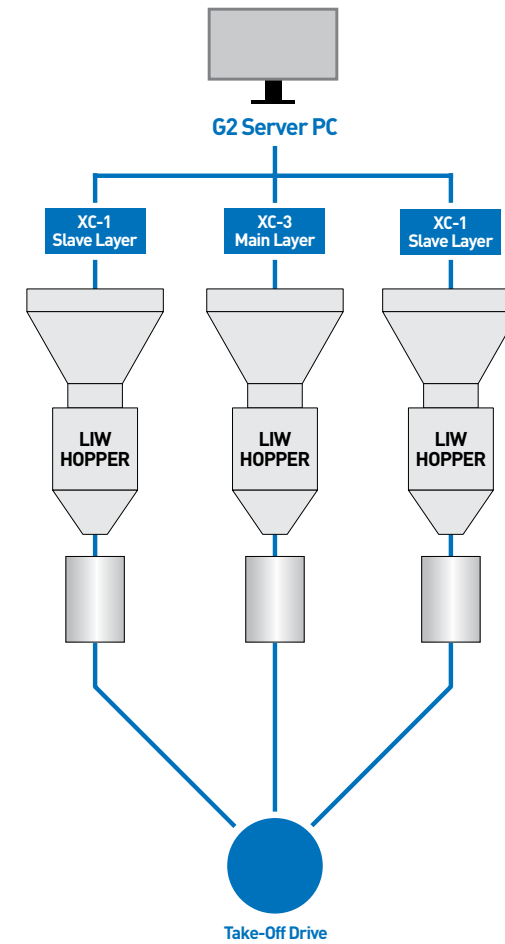
Model	Capacity		Throughput		LIW Dimensions										Weight	
	ft³	Litre	lb/hr	kg/hr	A		B		C		D		E		lb	kg
					in	mm	in	mm	in	mm	in	mm	in	mm		
LIW-05W	0.3	8.5	5-300	2-136	23.5	597	12	305	14.2	361	18.2	462	6 x 6	152 x 152	56	25.5
LIW-10W	0.6	17	100-600	45-272	26.5	673	16	406	17.7	449	20	508	10 x 10	254 x 254	74	33.6
LIW-25W	1.6	45.3	500-1500	228-682	35.5	902	17.7	449	22	559	26	660	10 x 10	254 x 254	120	54.6
LIW-40W	2.5	70.8	1000-3000	454-1364	42.5	1080	23.7	602	22	559	26	660	10 x 10	254 x 254	140	63.6

Maguire reserves the right to cancel product or change product, product specifications and data without notice to improve reliability, function, design or otherwise.

Model Dimensions



Co-Extrusion Option



LineMaster Payback

LineMaster™ generates fast payback through quick set-up and reduced waste.

SINGLE LAYER BLOWN FILM

4% Material savings, 5-month payback

After twelve months of commercial production on a single blown film line using LineMaster Extrusion Control, a processor in the United Kingdom reports that it has reduced raw material consumption by 4% (54,912 lb or 24,908 kg/yr) and improved gauge uniformity.

As a result, the cost of LineMaster – *which works in conjunction with Maguire Weigh Scale Blenders* – was amortized in five months.

3-LAYER CAST SHEET

Inner-layer control

A multinational manufacturer of film and sheet products installed LineMaster on a three-layer cast sheet line. The line produces 60 and 80 mil (0.015 to 0.020 mm) co-extruded sheet with a 20/60/20 ratio of skin layers to core.

Even though this sheet line contained state-of-the-art extrusion die and nuclear gauging equipment, sheet examined by the company was found to be defective, not in terms of overall thickness specifications, but because of substantial variances in the thickness of discrete layers.

After installing the LineMaster and slaving extruder RPM to three gravimetric blenders, the customer was able to maintain a consistent flow of material through the die for each extruder, resulting in higher-quality co-extruded sheet products. In effect, the gauging system now controls the automatic die to keep the overall thickness constant, while the blenders control material flow to ensure consistent layers.

PVC PROFILE

One month payback

A PVC profile manufacturer reports that by installing the LineMaster system on a 500 kg/hr extrusion line, the company produced more on-specification profile at that rate, enhanced quality, saved raw material, shortened times for job setups and changeovers, and virtually eliminated scrap.

While the company has asked Maguire not to disclose its identity, it has provided data showing that the process improvements achieved with the LineMaster yield control paid for the investment in the system in less than a month.



3-LAYER BLOWN FILM

IG industries saves \$100,000 per line

Use of LineMaster extrusion yield control to produce a single three-layer blown film has enabled IG Industries PLC, a custom manufacturer of polyethylene films in the United Kingdom, to obtain an increase in saleable output by USD \$100,000 per line.

12% material savings

"Maguire's LineMaster system has enabled us to maintain extremely precise layer ratios and to produce roll-stock with weights that are virtually identical from one roll to the next," says Co-extruded Film Technologies' Bob Boden.

"Our control over layer ratios has resulted in films with consistent heat sealing and mechanical properties – an achievement which has proved invaluable for supplying quality film for high-speed wicketed bag production. We reduced material consumption by 12%".



WIRE AND CABLE

Improved quality and increased yield

LineMaster technology enabled Prysmian Cable, Inc. to increase control over the ratio between the raw materials used in a cable construction – control that is critical for balancing fire resistance with mechanical strength. The system maintains the target ratio, in grams per meter, between the various raw materials at each stage of production and ensures that, in the finished cable, the weight of each compound per unit of length is constant.

A basic job of the LineMaster system is to adjust the many variables that affect the rate at which extruders consume raw material, such as the source of the material, storage conditions, density, particle geometry, die and heater conditions, screen packing, and fluctuations in electrical power. The system includes control software and a loss-in weight (LIW) hopper that gravity-feeds material into the processing machine.

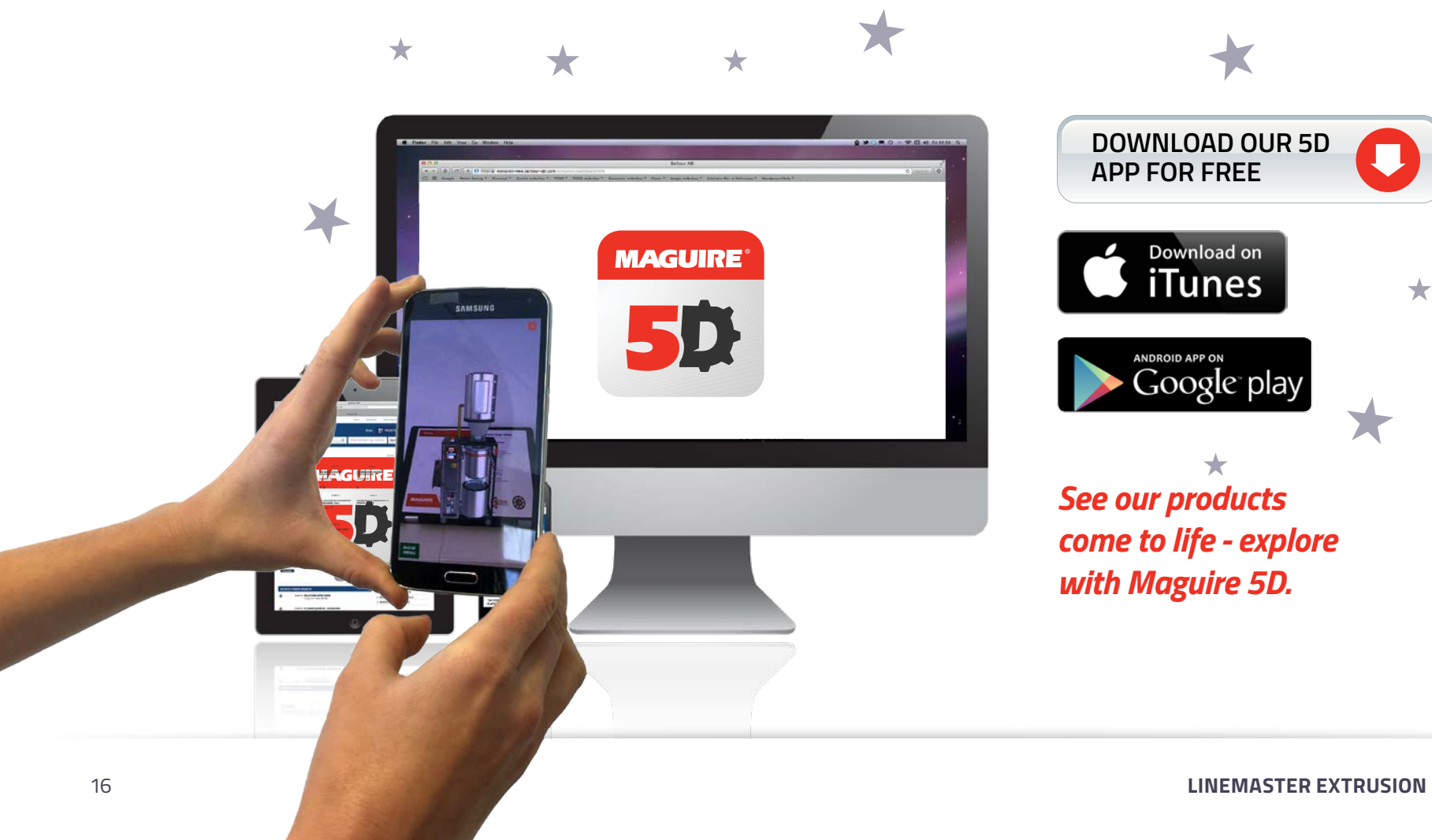
This technology can be deployed as a stand-alone system or to work in concert with a blender such as the Maguire® Weigh Scale Blender.

A basic job of the LineMaster system is to adjust the many variables that affect the rate at which extruders consume raw material.

Maguire 5D – watch our products come to life

Download our Maguire 5D app and explore our WSB blender, VBD Vacuum Dryer and Liquid Colour products in a more detailed experience. Available at Android and iOS stores – just search for **Maguire 5D**.

For printable targets for these products, refer to our **Maguire 5D** webpage and start exploring NOW: <http://www.maguire.com/page.php/5d.htm>





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