WOODWARD

**Application Note 51317**
**(Revision NEW)**
**Original Instructions**

# ProAct™ Digital Speed Control System with Start-up Fuel Limiting

## Addendum to Manual 04121

**General Precautions**

**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.**

**Practice all plant and safety instructions and precautions.**

**Failure to follow instructions can cause personal injury and/or property damage.**

**Revisions**

**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:**

**www.woodward.com/publications**

**The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.**

**Proper Use**

**Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.**

**Translated Publications**

**If the cover of this publication states "Translation of the Original Instructions" please note:**

**The original source of this publication may have been updated since this translation was made. Be sure to check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.**

**Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.**

# Contents

**WARNINGS AND NOTICES ..... 2**

**ELECTROSTATIC DISCHARGE AWARENESS ..... 3**

**PROACT™ DIGITAL SPEED CONTROL SYSTEM WITH START-UP FUEL LIMITING ..... 4**
General Description....4
Start Fuel Limiting....4
Triple Start Fuel Limits....4
4–20 mA Remote Rack Limiter Map ....7
Lower Speed Threshold ....7

**APPENDIX. MENU SUMMARY..... 8**
Initial Prestart Settings....8

# Illustrations and Tables

Figure 1. Triple Start Fuel Limiting ....5
Figure 2. Complete Torque Map ....6
Figure 3. 4–20 mA Remote Rack Limiter Map ....7

# Warnings and Notices

## Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

**⚠WARNING**

**Overspeed / Overtemperature / Overpressure**

**The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.**

**The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.**

**⚠WARNING**

**Personal Protective Equipment**

**The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:**

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

**Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.**

**⚠WARNING**

**Start-up**

**Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.**

**⚠WARNING**

**Automotive Applications**

**On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.**

**NOTICE**

**Battery Charging Device**

**To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.**

# Electrostatic Discharge Awareness

**NOTICE**

**Electrostatic Precautions**

**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:**

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

**To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

# ProAct™ Digital Speed Control System with Start-up Fuel Limiting

## General Description

This brief specification describes the functionality for Start Fuel Limiting using Stages using the ProAct™ Digital Speed Control System for Models I and II.

## Start Fuel Limiting

This section describes the Start Fuel Limit feature using three stages. Two stages are needed to limit smoke during start-up while still achieving fast start times. The third stage is provided to allow for performance due to cold engine starts in the winter. The Start Fuel Limiting feature is cancelled after Start Speed is reached, and will not be activated again until after zero speed is detected.

## Triple Start Fuel Limits

Triple Start Fuel provides three start fuel stages. Triple Start Fuel works like three sequential Start Fuel position settings with a ramp between each and works as a position control algorithm. The speed control governor is not running during the start fuel limiting stages. Once Start Speed is reached, the governor is then activated for the ramp to idle (or rated) and remains in control until Zero speed is detected.

When Start Speed BreakPoint 1 threshold is reached, the Start Fuel Limit 1 position setting is ramped to the Start Fuel Limit 2 position setting at the configured Start 1-2 Ramp Rate. Setting this rate to its maximum value effectively eliminates the ramp. When Start Speed BreakPoint 2 threshold is reached, the Start Fuel Limit 2 position setting is ramped to the Start Fuel Limit 3 position setting at the configured Start 2-3 Ramp Rate. Setting this rate to its maximum value effectively eliminates the ramp. The Start Fuel Limits (1, 2, and 3) can be set at any level with respect to each other. The Start Speed BreakPoint thresholds should be set incrementally so that Start Speed BP 1 is lower than Start Speed BP 2, which is also lower than Start Speed (however, this will not be inhibited by configuration of the hand-held programmer). See Figure 1 below.

### Ramps

While start fuel limiting is engaged, the ProAct control is operating in a actuator position control mode. It is not possible to control rpm, but rpm is used for position limit threshold switching.

The fuel position will increase at the Start Ramp Rate until the Start Speed BP 1 is reached (or the Max Fuel Limit is reached). The increasing ramp (Start Ramp Rate) will NOT be used during the second and third Start Fuel Limit stages.

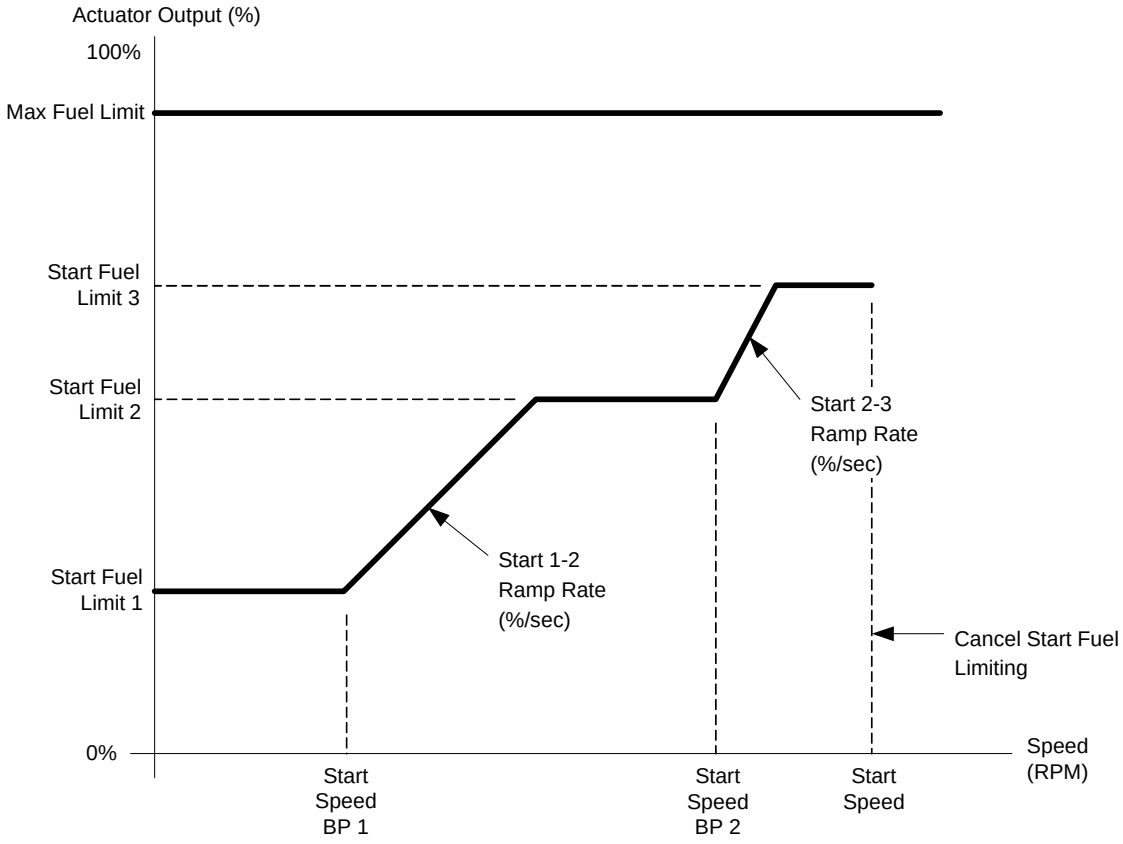


Figure 1. Triple Start Fuel Limiting

Once the Start Speed is reached, the fuel position limit will be set to the Min Torque Limit, but the actuator position will be controlled using the governor and the governor ramp rates. Specifically, the speed will be ramped to the Idle Speed using a rate determined by the Accel Time. Idle Speed will be maintained until the Idle/Rated input is selected. When Rated Speed is selected by closing the Idle/Rated switch contact, the fuel limit is set to the Maximum Fuel Limit set point value or the Torque Limit, whichever is less, for the current engine operating speed. The speed reference selected at this time is determined by the status of the Enable Remote switch. If Remote reference is not selected (Remote reference switch contacts open), the speed reference will ramp from idle to rated speed, based on the Accel Time set point. Closing either the Raise or Lower contacts (or the Remote contacts) while ramping from idle to rated results in immediate cancellation of the idle-to-rated ramp. The Raise/Lower ramp rates will take over depending on whether Raise or Lower is selected.

This feature expects Idle Speed to be set higher than Start Speed. If Idle Speed is configured to a value lower than Start Speed, the control will DECREASE the engine speed to the Idle Speed at the Lower Rate. When Rated Speed is selected, the same procedure as above will be followed.

If Idle is not used, the control will ramp to Rated Speed using a rate determined by the Accel Time directly from Start Speed.

## Torque Limit

The Torque Limit is in reality an actuator position limit function. During start fuel limiting, the actuator operates in position control only. However, during run conditions (after Start Speed is first reached), the actuator operates in speed control with a position limit function imposed on the actuator position resulting from the speed control function. This implementation is called a Torque Limit. Figure 2 shows the torque limits imposed from start-up through running as a complete map. However, once Start Speed is reached, the torque (position) limits imposed by the start fuel-limiting feature are no longer applied even if the speed drops below the Start Speed (in this case, the Min Torque is used).

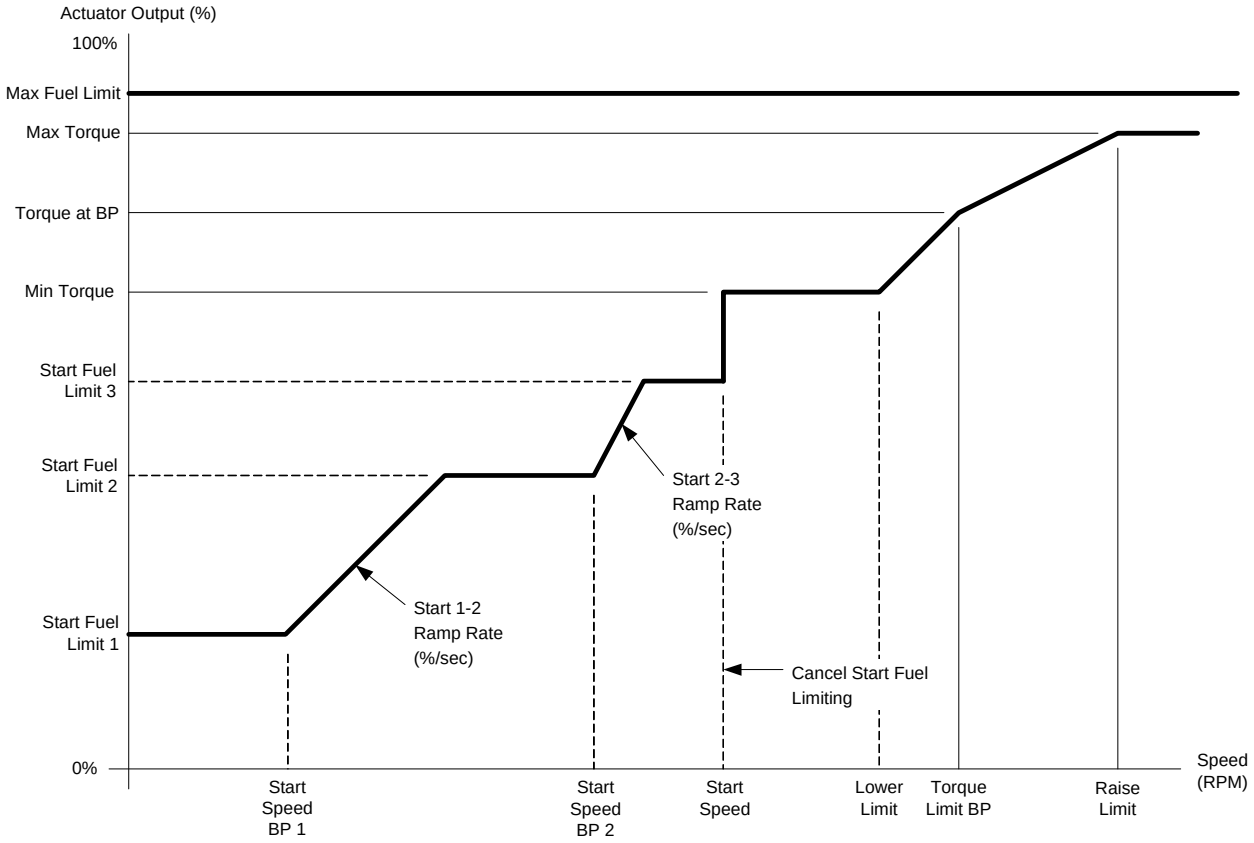


Figure 2. Complete Torque Map

## 4–20 mA Remote Rack Limiter Map

A 4–20 mA Remote Rack Limiter Map feature exists in the ProAct. This feature is intended to activate only when Start Speed or the Lower Limit speed are reached (whichever is higher). This map works in conjunction with the Torque Limit. The rack is limited to whichever is lower between the Torque Limit and 4–20 mA rack limit.

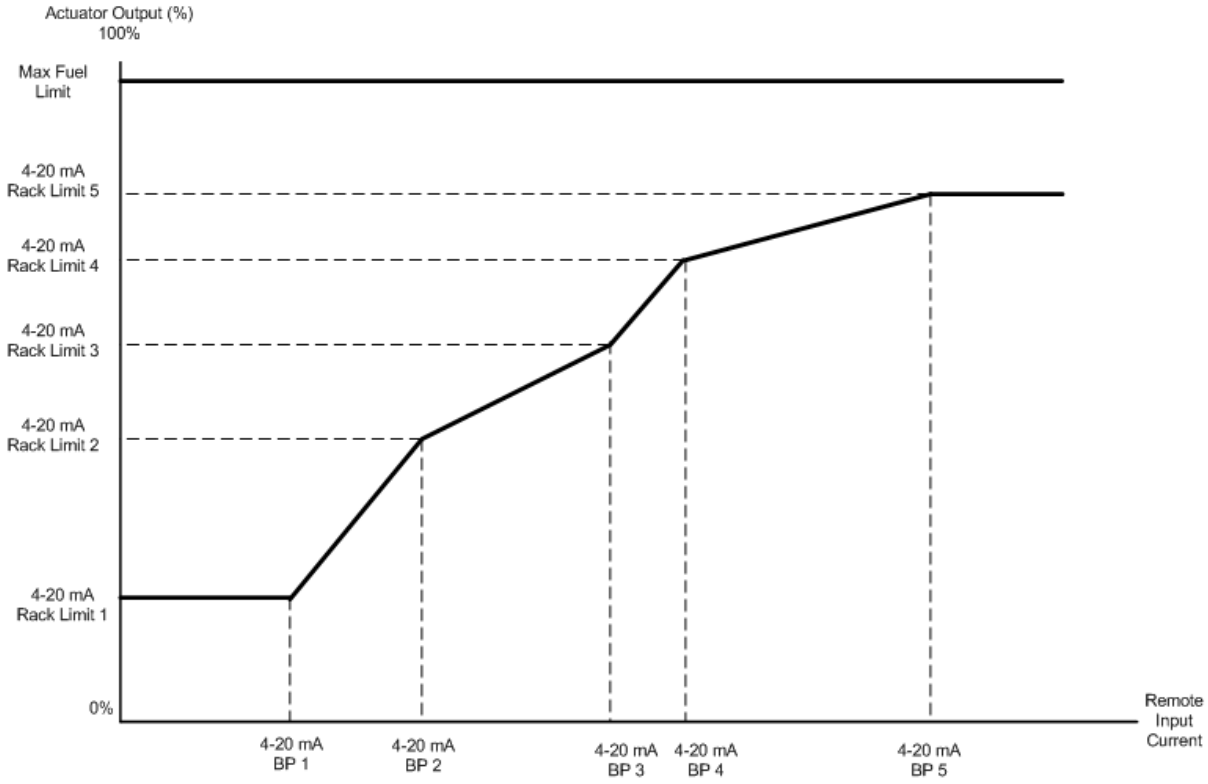


Figure 3. 4–20 mA Remote Rack Limiter Map

## Lower Speed Threshold

There is a hard-coded value for minimum speed below which the ProAct will not attempt to operate. This value is currently at 3% of Rated Speed to facilitate easier engine starting under extreme cold conditions.

# Appendix.
# Menu Summary

## Initial Prestart Settings

These tables are provided for the convenience of the ProAct™ user. Each number should be recorded as it is programmed with the Hand Held Programmer. Any changes should be noted so the adjustment can be referenced from its original setting.

### Menu 3 – Speed Reference Settings

| Menu Item | Default Setting | Actual Setting |
|---|---|---|
| Rated Speed | 1800 rpm | |
| Idle Speed | 1200 rpm | |
| Raise Limit | 1890 rpm | |
| Lower Limit | 1200 rpm | |
| Accel Time | 8 sec | |
| Decel Time | 3 sec | |
| Raise Rate | 2500 rpm/min | |
| Lower Rate | 2500 rpm/min | |
| Droop | 5% | |
| Idle Droop | 0% | |
| Idle Droop BP | 0% | |
| Speed Switch A On | 600 rpm | |
| Speed Switch A Off | 540 rpm | |
| Speed Switch B On | 1200 rpm | |
| Speed Switch B Off | 1140 rpm | |
| Speed Switch C On | 2000 rpm | |
| Speed Switch C Off | 1900 rpm | |

## Menu 4 – Limiter Settings

| Menu Item | Default Setting | Actual Setting | Description |
|---|---|---|---|
| Max Fuel Limit | 100% | | Unchanged |
| Transient Limit | 0% | | Unchanged |
| Transient Time | 0 sec | | Unchanged |
| Start Ramp Rate | 1%/sec | | Unchanged |
| Start 1-2 Ramp Rate | 100%/sec | | Ramp Rate from Start 1 Fuel Limit to Start 2 Fuel Limit |
| Start 2-3 Ramp Rate | 100%/sec | | Ramp Rate from Start 2 Fuel Limit to Start 3 Fuel Limit |
| Start Fuel Limit 1 | 20% | | Primary Fuel Limit is always used |
| Start Fuel Limit 2 | 40% | | Second Fuel Limit when 2 Fuel Limits are Enabled |
| Start Fuel Limit 3 | 40% | | Third Fuel Limit when 3 Fuel Limits are Enabled |
| Start Speed BP 1 | 400 rpm | | Speed threshold at which Start Fuel Limit 2 is activated |
| Start Speed BP 2 | 400 rpm | | Speed threshold at which Start Fuel Limit 3 is activated |
| Start Speed | 400 rpm | | Speed threshold that Start Fuel Limiting is disabled |
| Stop Speed | 300 rpm | | Speed threshold that Start Fuel Limiting is enabled |
| Start Fueling | 1 | | Number of Start Fuel Limits Enabled |
| Min Torque Limit | 50% | | Unchanged |
| Torque Limit BP | 1500 rpm | | Unchanged |
| Torque Limit at BP | 70% | | Unchanged |
| Max Torque Limit | 90% | | Unchanged |
| 4–20 mA BP 1 | 10% | | 4–20 mA breakpoint 1 (4 mA = 0% breakpoint, 20 mA = 100% breakpoint). |
| 4–20 mA Rack Limit 1 | 100% | | Fuel rack is limited to Rack Limit 1 until BP 1 is reached. |
| 4–20 mA BP 2 | 10% | | 4–20 mA breakpoint 2 (4 mA = 0% breakpoint, 20 mA = 100% breakpoint). |
| 4–20 mA Rack Limit 2 | 100% | | Fuel rack limit is linearly interpolated from Rack Limit 2, BP 2 to Rack Limit 3, BP 3 (4 mA = 0% rack limit, 20 mA = 100%). |
| 4–20 mA BP 3 | 20% | | 4–20 mA breakpoint 3 (4 mA = 0% breakpoint, 20 mA = 100% breakpoint). |
| 4–20 mA Rack Limit 3 | 100% | | Fuel rack limit is linearly interpolated from Rack Limit 3, BP 3 to Rack Limit 4, BP 4 (4 mA = 0% rack limit, 20 mA = 100%). |
| 4–20 mA BP 4 | 30% | | 4–20 mA breakpoint 4 (4 mA = 0% breakpoint, 20 mA = 100% breakpoint). |
| 4–20 mA Rack Limit 4 | 100% | | Fuel rack limit is linearly interpolated from Rack Limit 4, BP 4 to Rack Limit 5, BP 5 (4 mA = 0% rack limit, 20 mA = 100%). |
| 4–20 mA BP 5 | 40% | | 4–20 mA breakpoint 5 (4 mA = 0% breakpoint, 20 mA = 100% breakpoint). |
| 4–20 mA Rack Limit 5 | 100% | | Fuel rack is limited to Rack Limit 5 after BP 5 is reached. (4 mA = 0% rack limit, 20 mA = 100%). |

**We appreciate your comments about the content of our publications.**

**Send comments to: icinfo@woodward.com**

**Please reference publication 51317.**

PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

**Email and Website—www.woodward.com**

**Woodward has company-owned plants, subsidiaries, and branches,
as well as authorized distributors and other authorized service and sales facilities throughout the world.**

**Complete address / phone / fax / email information for all locations is available on our website.**

2012/11/Colorado