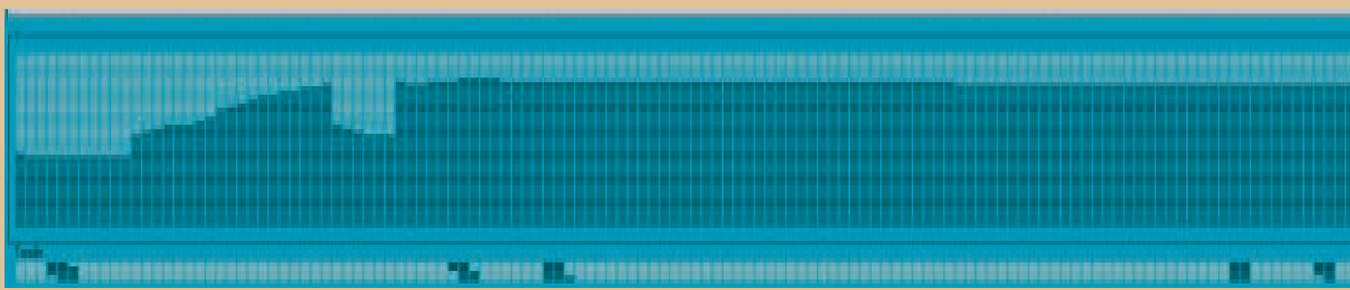
MODEL 353

TDS
TRANSPORT DATA SYSTEMS



DUAL SCANNER REMOTE VEHICLE EVALUATION SYSTEM

This system provides the capability of generating vehicle alarms when a vehicle exceeds a specified limit associated with that vehicle class. The class determination is based on vehicle length, height profile, width profile, axle location, dual tires and weight per axle/tire. An alarm is generated when the vehicle exceeds height, width, speed or weight per axle/tire limits as defined by the customer. When an alarm is generated, the system captures video images of the front and side of the vehicle to provide for identification. The extracted license number and the associated images can be forwarded to a central server for insertion into a central database of violations.

The integration of image capture with weigh-in-motion and vehicle classification enables the user to significantly enhance weight enforcement and infrastructure planning. The use of this system into a weight enforcement strategy provides significant benefits in terms of improved commercial vehicle safety, ensuring equitable competition in the commercial carrier industry and protecting public and private road assets from excessive and accelerated damage caused by overloaded commercial vehicles.

This technology has a number of applications in commercial vehicle weight enforcement, infrastructure development and road asset maintenance planning. It can be used to augment permanent weigh station operations by providing images and classifications for mainline WIM pre-screening systems, monitoring vehicle compliance to WIM sorter traffic signals and traffic signs, and for monitoring weigh station evasion routes. It may also be deployed in conjunction with mobile and remote weight enforcement as a pre-screening system, or as an automated stand alone monitoring system on remote routes. The data from this system can provide agencies with a visual record from which to engage in discussions with particular carriers detected as chronic violators, or to assign preferred carrier status. The system may also be deployed in support of transportation planning activities to assist traffic engineers to evaluate future capital developments or help road asset managers plan preservation programs across specified segments of the road infrastructure. Other applications include urban weight enforcement and concentrated haul road weight enforcement. Finally the system can be employed on toll roads to provide a more equitable method of assessing costs for patron use of the road.

This design uses dual overhead laser scanners to provide an excellent width profile without shadowing. It is based upon TDS's extensive experience in the fields of automatic vehicle classification, license plate capture and violation enforcement. TDS has over 400 lanes of high accuracy automatic vehicle classifiers and image capture systems in operation on toll roads.

OPERATIONAL PHILOSOPHY

To create a remote vehicle evaluaion system, Transport Data Systems has integrated its Weigh-In-Motion (WIM) vehicle classifier and image capture products. The system uses quartz sensors from Kistler to provide the raw pressure inputs from the tire crossings. This information coupled with accurate velocity data from the Doppler radar delivers accurate wheel by wheel weight measurements.

The Kistler quartz sensor provides a measure of the total pressure that is applied to the sensor during the period that the wheel is actually on the sensor. To determine the actual weight, the unit requires the speed of the vehicle. Classically system designers have included multiple loops to determine the velocity of the vehicle and to provide vehicle separation. The TDS design uses the velocity provided by the Doppler radar to generate a very reliable weight measurement.

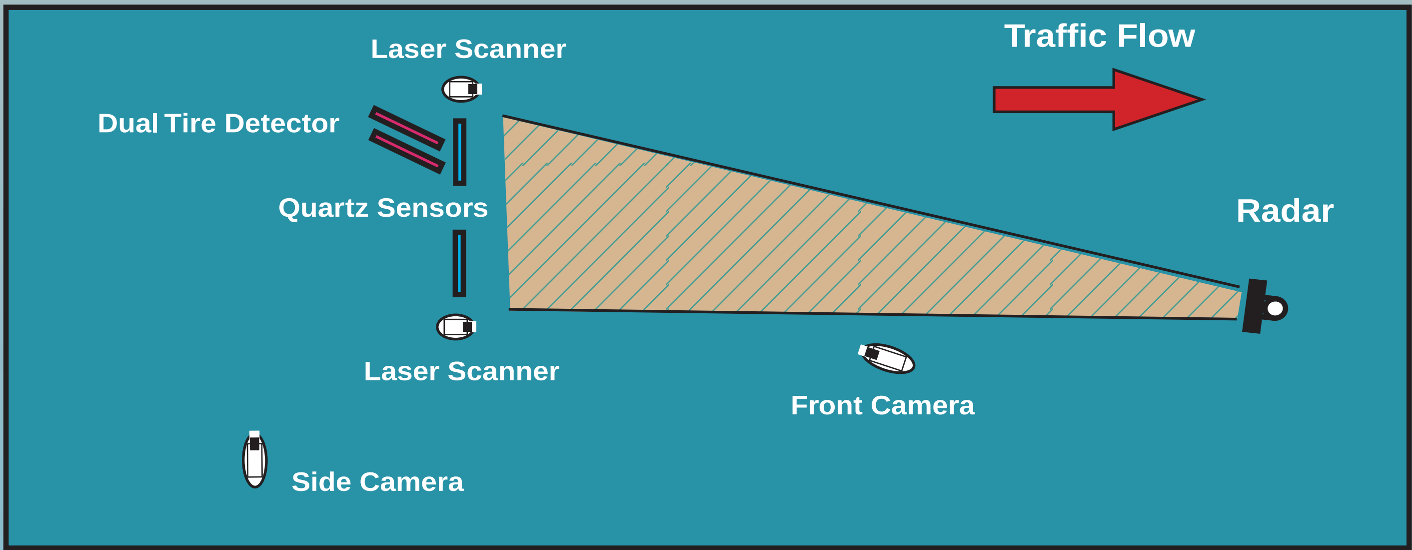
The TDS system uses dual laser scanners with a Doppler radar to provide the ability to separate vehicles and profile them in width and height without shadowing. The Doppler radar provides a very accurate instantaneous velocity measurement 16 times a second. This velocity plus the quartz sensor outputs can provide accurate and reliable vehicle weight information. It also provides for excellent vehicle separation.

The quartz sensors can also fill the requirement for axle detection, thereby eliminating the need for additional axle detectors. A separate fiber optic based dual tire detector allows the user to determine the existence of dual tires on each axle.

This combination allows the processor to evaluate each vehicle using axle locations and tire counts along with length and width and height profiles.

In order for the quartz sensors to operate properly, the vehicle can not stop on the sensors. Therefore in siutations where stop and go traffic exists on a regular basis, it is imperative that the vehicles be metered through the measurement area. In order to accomplish this, a separate traffic light and/or gate is used to control the entry of the vehicle into the measurement zone. This technique not only guarantees a more accurate weight measurement but also increases the fundamental accuracy of the vehicle classifier.

Front and side images are captured for every vehicle. An alarm is generated when an out of tolerance vehicle is detected. The captured images are then stored locally in a database for review and can also be transmitted to a remote station or to a central server for additional processing.



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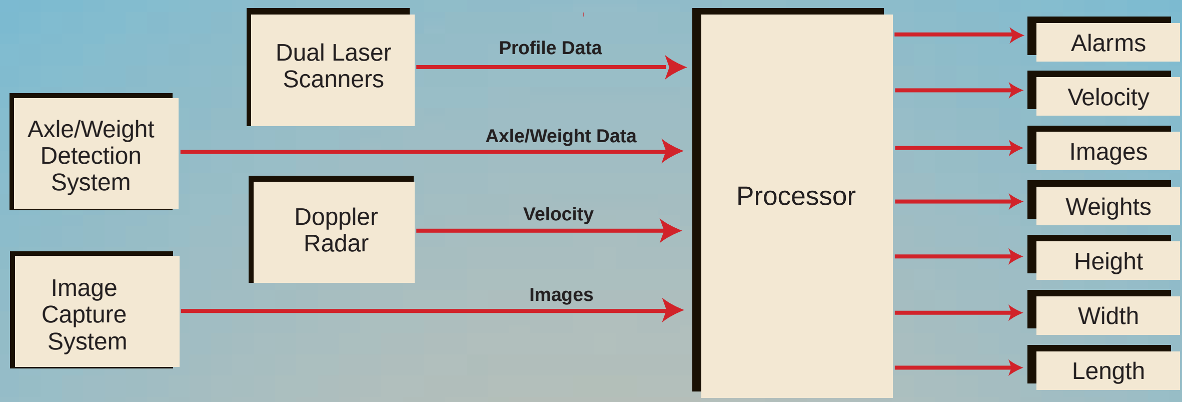

BASIC DESIGN

The basic building blocks of the system include 2 laser overhead scanners, a high frequency CW Doppler radar, an axle/weight/dual tire detection system and a computer system for processing the sensor data. The system is capable of providing the following information about a vehicle.

- Length of the vehicle(s) and hitch location.
- Number, weight and location of axles.
- Existence of dual tires.
- Height profile.
- Width profile with no shadowing.
- Vehicle speed.

SPEED DETECTION

A key element in this design is the use of the CW Doppler radar. The radar provides very accurate velocity on the target as it passes over the weight sensors. The radar beam pattern is designed to cover a single lane when mounted 35 to 45 feet from the vehicle separator. This pattern size eliminates false detection of vehicles in adjacent lanes.

AXLE/WEIGHT DETECTION

The axle/weight detection system provides information about each axle on the vehicle. The weight sensing is done by Kistler Lineas quartz sensor. The quartz sensors provide an indication that a axle is passing through the weighing zone. The quartz sensor transmits pressure data that when combined with the radar velocity provides an accurate measurement of the weight of the axle. The optional dual tire detector provides the number of tires on each axle.

PROCESSOR

The processor is an Intel based PC running the Linux operating system. The interface to the central server or remote usesr is available in serial form via RS-422 or via a 10/100baseT network connection.

IMAGE CAPTURE SYSTEM

The system will capture an image of the vehicle for use in determining the ownership of the vehicle. The image capture system can be set up to capture either the front license plate of the vehicle or the right hand side of the vehicle including the USDOT number. If required two cameras can be implemented within a single processor to provide for both images.

This camera will provide high resolution lane coverage over a capture area of approximately 10 feet wide by 6 feet high. The size of this coverage coupled with accurate triggering insures that a single image will include the vehicle license plate. The resolution of the camera coupled with the low noise performance provides an excellent image for optical character recognition. TDS has developed a companion OCR package for use with this camera.

QUARTZ SENSOR

Kistler's LINEAS WIM Type 9195C is a force sensor with quartz elements. The sensor is a modular element that is installed into a slot that has been saw-cut across an asphalt or concrete road. When a force is applied to the sensor surface, the quartz disks yield an electric charge proportional to the applied force through the piezoelectric effect. The electric charge is converted by a charge amplifier into a proportional voltage which can then be processed as required. Key characteristics include:

- Excellent long term stability.
- Measures very accurately at both walking and freeway speeds.
- Insensitive to temperature changes.
- Frost-resistant and protective against ingress of water.
- Quasistatic and dynamic calibration are possible.
- Wide measuring range.

The sensor is not dislodged from the road and can be reground by up to 10 mm in the event of road deformations.

The sensors are available in 0.75 and 1.0 meter lengths. Two or more sensors can be connected together to make a longer single sensor strip. Several sensors that are installed adjacent to one another can be connected electrically in parallel and operated with a single charge amplifier. The output signal then corresponds to the sum of the forces acting simultaneously on all sensors connected.

A sand/epoxy grout secures the sensor strips into the pavement slots. After curing, the hardened grout and the exposed top surfaces of the sensor modules are ground flush with the surrounding pavement using a belt sander. After grinding, the sensors may be immediately exposed to traffic. An overnight post cure is recommended before calibration and acceptance tests are performed.

CHARGE AMPLIFIER

The industrial charge amplifier (Type 5038A2Y43) is a 2 channel amplifier. Each channel converts the charge output of the Lineas sensor to a proportional voltage. The adjusting potentiometers are designed as plug in units to avoid the need for recalibration when an amplifier is replaced. The unit requires an unregulated 15 to 20 volt DC supply. Its key features include:

- Robust aluminum diecast housing
- Vibration proof
- No adjustments required

The outputs of the sensor amplifier are brought to the lane controller over special cables capable of extending the distance from the sensor amplifier to over 80 feet. The signals are fed into a digital processing card which contains a 12 bit analog to digital converter.

DUAL TIRE DETECTOR

The dual tire detection will use two fiber optic treadles, each with a length of 1.7 meters. The two fiber optic treadles are placed at a nominal 35 centimeter (14 inch) separation at an angle of 30 degrees relative to the flow of traffic. The fiber optic treadle can be installed directly into the road surface.

In those applications where a quicker replacement is required, TDS offers a steel treadle frame and carrier combination. The frame is installed into the roadway and the carrier is then bolted into the frame. The fiber treadle is encapsulated with resin into the carrier by TDS. The user then installs the carrier into the frame. The fiber cable is routed through the junction box on the end of the frame. This allows for the replacement of a failed treadle in less than two hours using standard tools.

The fibers are connected to a two channel amplifier located near the RWS processor. The outputs of the amplifier are sent to the RWS processor via an RS-422 serial channel.

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