Final Report

Measuring Pavement Friction Characteristics at Variable Speeds for Added Safety

FDOT Order No. DO-51684 (DO-2022)

Report Date
July 31, 2005

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
# DO-51684 (DO-2022)		

4. Title and Subtitle	5. Report Date
Measuring Pavement Friction Characteristics at Variable Speeds for Added Safety	**July 31, 2005**
	6. Performing Organization Code
7. Author(s) **N. Mike Jackson, Ph.D., P.E.**	8. Performing Organization Report No.
9. Performing Organization Name and Address **University of North Florida, Division of Engineering** **4567 St. Johns Bluff Road, South** **Jacksonville, Florida 32224-2645**	10. Work Unit No. (TRAIS) 11. Contract or Grant No. **FDOT Order # DO-51684 (DO-2022)**
12. Sponsoring Agency Name and Address **Florida Department of Transportation** **605 Suwannee St. MS 30** **Tallahassee, Florida 32399** **(850)414-4615**	13. Type of Report and Period Covered **Final Report** 14. Sponsoring Agency Code

15. Supplementary Notes

Prepared in cooperation with the USDOT and FHWA

16. Abstract

Pavement friction testing is frequently conducted in accordance with the provisions outlined in ASTM E 274, "Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire." The standard speed of testing in Florida is 40 mph (64.4 km/h). However, due to safety concerns related to testing on high-speed facilities, considerable attention has been focused in recent years on height-sensor based (non-contact) technology. Such sensors are potentially well suited for surveying the surface texture characteristics of pavement sections while operating at highway speeds.

Although the height-sensor based technology has been available since the 1960s, it continues to mature. A considerable amount of research has been conducted to gain further understanding on the factors affecting high-speed pavement surface surveying from both the analytical and experimental points of view. Still some problems have not fully been resolved, particularly in the interpretation of the measured data and selection of adequate sensing technology (or sensor designs).

The Florida Department of Transportation (FDOT) initiated the present study to assess the feasibility of using high-speed, laser-based sensors to quantify the texture and friction characteristics of asphalt pavements. The main objective of this study is to provide for a safer, faster and more appropriate method of estimating pavement friction characteristics on high-speed facilities, ramps, and at other potentially hazardous sites. Further, it is also intended to provide for a means to obtain a measure of International Friction Index (IFI) in accordance with ASTM E 1960. This report presents a description of the FDOT testing program, the data collection effort as well as the subsequent analyses and findings.

17. Key Word	18. Distribution Statement
Pavement Texture, Friction Testing, International Friction Index, Skid Resistance	**No Restriction** **This report is available to the public through the NTIS, Springfield, VA 22161**

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	**Unclassified**	**28**	

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Si* (Modern Metric) Conversion Factors

APPROXIMATE CONVERSIONS TO SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	squareinches	645.2	square millimeters	mm^2
ft^2	squarefeet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^{o}F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^{o}C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

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Executive Summary

Under a contract with the University of North Florida (UNF), a LMI Technologies, Selcom, Optocator 64 kHz laser system was installed on a selected FDOT Pavement Friction Testing Unit. Subsequently, five FDOT calibration sections, located in the vicinity of the State Materials Research Park in Gainesville, Florida were tested. These five calibration sections represent a wide range of surface textures, including both dense-graded and open-graded friction courses common to Florida state roadways.

The tests conducted on each calibration section included: (1) friction testing in accordance with ASTM E 274, using both the standard ribbed tire, as described in ASTM E 501, and the smooth tire, as described in ASTM E 524; (2) non-contact, macrotexture measurement, using the 64 kHz laser system installed on the FDOT Pavement Friction Testing Unit, in accordance with ASTM E 1845; and (3) volumetric macrotexture measurement in accordance with ASTM E 965, "Standard Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique," more commonly referred to in practice as the "Sand Patch" test.

The results of this study demonstrate that the 64 kHz non-contact, macrotexture measurement system described herein provides a repeatable and accurate measure of Mean Profile Depth (MPD). Further, linear regression relationships observed between Mean Texture Depth (MTD) and MPD, as developed from the 64 kHz laser are similar to the transformation equation provided in ASTM E 1845. This confirms that the 64 kHz laser may be used to provide a reasonable estimate of MTD. It should be noted, however, that this macro-texture measurement was found to be a poor predictor of overall pavement friction.

With a repeatable measure of MPD and wet friction, International Friction Index (IFI) can be reported in accordance with ASTM E 1960. An example is provided of how FN_{40} data, as obtained from ASTM E 274, and MPD, as obtained from the 64 kHz laser can be transformed for IFI reporting. It is anticipated that a follow-up study will be conducted at a future date for calibration/harmonization of FDOT friction test data for IFI reporting. It is envisioned that this follow-up effort will further promote the implementation of IFI within the FDOT.

In summary, the results of this study, when fully implemented, will yield a safer, faster and more appropriate method of estimating pavement friction characteristics on high-speed facilities, ramps, and other potentially hazardous sites in Florida.

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Measuring Pavement Friction Characteristics at Variable Speeds for Added Safety

1.0 Introduction

The Florida Department of Transportation (FDOT) has conducted standard friction tests on state roadways since 1958. The first Pavement Friction Testing Unit, meeting the requirements of ASTM Committee E-17 on Vehicle-Pavement Systems was fabricated for the Department in 1966. FDOT currently owns and operates four modern Pavement Friction Testing Units. Each of these Units consists of a tow vehicle, water tank, friction trailer, and mobile data processor. Friction measurements are obtained from the force induced on a locked test wheel as it is dragged over a wetted pavement surface. The mean Friction Number (FN) of the pavement surface is obtained from this test. All pavement friction testing currently performed by FDOT is conducted in accordance with the provisions outlined in ASTM E 274, “Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire [1].” Testing is typically performed at the specified speed of 40 mph (64.4 km/h), using the standard “Ribbed Tire” as specified by ASTM E 501, “Specification for Standard Rib Tire for Pavement Skid-Resistance Tests [2].”

Although the current FDOT friction testing program is fully implemented, there are several areas that need to be addressed, most importantly safety while conducting the test. The current specified test speed of 40 mph (64.4 km/h) is used on all state roadways including primary, secondary, interstates and toll roads. To maximize safety and minimize traffic disruption, friction testing is typically conducted on weekdays and sometimes at night. Nevertheless, there are still safety concerns related to potential conflicts with the motoring public on high-speed facilities, ramps, and at other potentially hazardous sites. In order to properly address these safety concerns, FDOT is currently evaluating the use of height-sensor based (non-contact) technology to accommodate variable testing speeds, comparable to the speed limit of the facility being tested.

2.0 Background

2.1 FDOT Friction Testing Program

Friction testing is conducted by FDOT on all newly constructed pavement surfaces; all overlays; spot hazard locations identified as having an unusual number of wet weather accidents; re-test locations; and special requests, including research test sections, milled surfaces, or bridge decks. Testing is performed in the center of the left wheel path of the traffic lane, and in both directions for four-lane and multi-lane roadways. For two-lane roadways, only one lane is tested, unless otherwise requested. As previously noted, FDOT uses the standard ribbed tire to obtain a measure of friction, FN_{40R} in accordance with ASTM E 501, unless otherwise noted.

2.2 Equipment and Calibration

FDOT currently maintains four skid trailers meeting the ASTM specifications, as previously described. A photograph of a typical FDOT unit is presented in Figure 1. These units are equipped with International Cybernetics Corporation (ICC) Mobile Data Recorders (MDR 4040) for automated data acquisition purposes. The units are calibrated biennially at the Central/Western Field Test and Evaluation Center, Texas Transportation Institute, Texas A&M University System, College Station, Texas. FDOT personnel verify the calibration of these units using a force plate transducer every thirty to forty-five days. Water flow verifications are also performed every six months to ensure proper water flow and distribution during testing. The units are also checked for repeatability on five test sections located in the vicinity of the State Materials Research Park in Gainesville, Florida after each calibration check.

2.3 Friction Testing at Variable Speeds

Due to safety concerns associated with friction testing on both high and low-speed facilities, testing at variable speeds has been proposed by some FDOT personnel. As previously noted, the ASTM and FDOT standard test speed is 40 mph (64.4 km/h). It is envisioned that appropriate correlations may be developed for test data obtained at the standard speed and data obtained at other speeds. ASTM has promoted this concept with the introduction of International Friction Index (IFI) in ASTM E 1960, "Standard Practice for Calculating International Friction Index of a Pavement Surface [3]."

2.4 Smooth-Tire Testing

In 1984, FDOT began collecting "Smooth-Tire" skid data at wet-weather accident sites in accordance with ASTM E 524, "Specification for Standard Smooth Tire for Pavement Skid Resistance Tests," in addition to ribbed tire data [4]. It has been documented that the ribbed tire test is predominantly influenced by micro-texture, whereas the smooth tire test is influenced to a greater extent by macro-texture [5]. Historical analysis of smooth-tire friction test data collected by FDOT at wet-weather accident sites is reproduced here in Figure 2 [6]. As presented by the horizontal line in Figure 2, corresponding to a mean smooth-tire Friction Number (FN_{40S}) of 25, the smooth tire data has been documented to correlate better with wet-weather accidents. As a result, additional smooth tire testing has been included in this study.

FIG. 1-Typical FDOT Pavement Friction Testing Unit Performing a Test

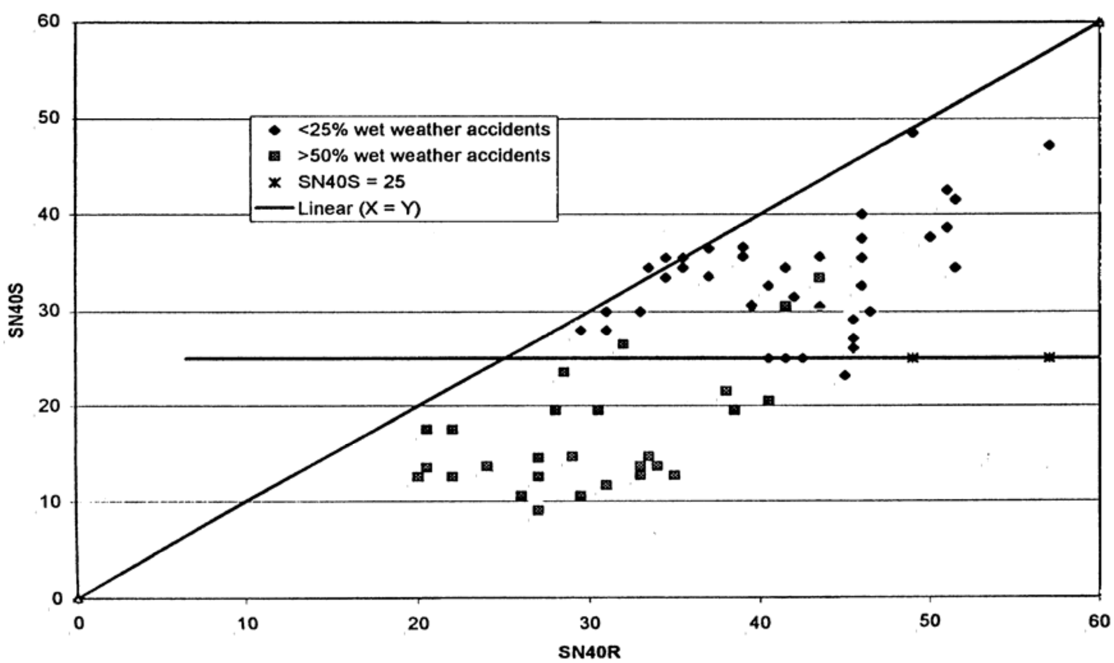


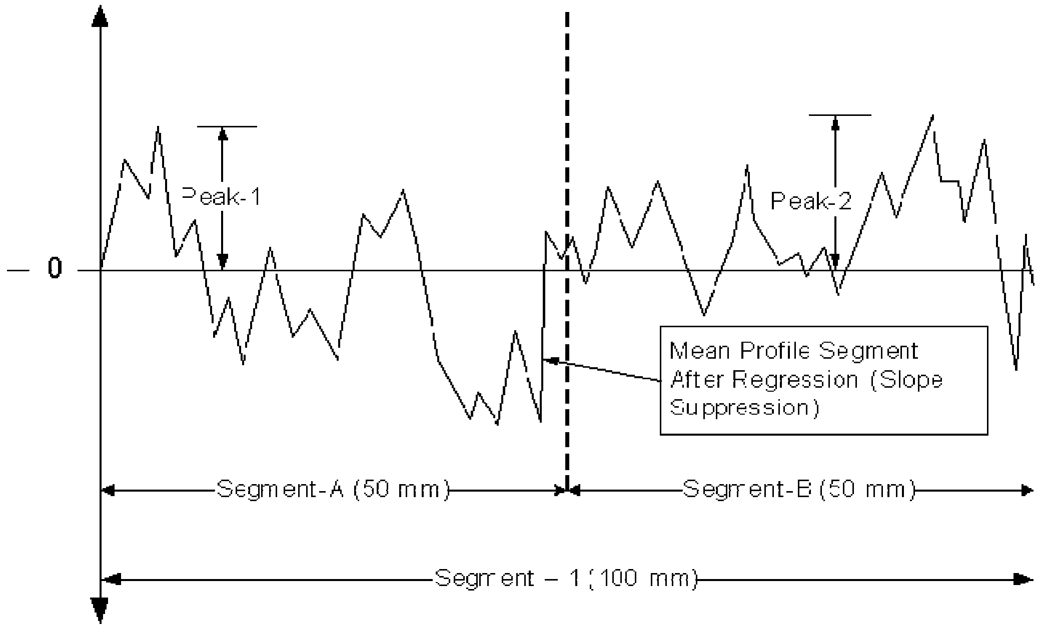
FIG. 2-Ribbed-Tire vs. Smooth-Tire Friction Numbers for Florida Pavements [6]

2.5 Recent Technological Advances

In recent years, technological advances in microprocessors and personal computers have made it possible to consider the use of high-speed lasers in the evaluation of pavement surface characteristics, such as profile, distress, and even texture. Research by others [7] has demonstrated that laser-based sensors have evolved to the point where they are now durable enough to be used in the field to measure pavement surface texture (macro-texture). The Texas Department of Transportation (TXDOT) currently employs 78 kHz lasers in the collection of texture data [8]. TXDOT and others have demonstrated that this technology has progressed to the point where it is possible to collect both surface texture measurements and friction data, simultaneously.

The measurement of pavement texture using high-speed laser technology has now been standardized in ASTM E 1845, "Standard Practice for Calculating Pavement Macrotexture Mean Profile Depth [9]." In accordance with ASTM E 1845, such laser texture data is processed as shown in Figure 3, to estimate the mean segment depth for a given 100 mm segment of pavement. Mean segment depths are averaged over the length of pavement section being tested to obtain the Mean Profile Depth (MPD).

Conversations with equipment manufacturer representatives (Selcom and ICC) have raised questions regarding the functional durability of lasers beyond about 78 kHz in speed [10 and 11]. In addition, it is expected that the number of invalid data points collected at such high speeds would be significant in Florida, where open-graded surfaces are common. For these reasons, it was recommended by both Selcom and ICC that FDOT explore the use of a 64 kHz laser for texture measurement in this initial study.



ASTM E 1845-01: Standard Practice for Calculating Pavement Macrotexture Mean Profile Depth

Mean Segment Depth $_{Segment 1}$ = (Peak-1 + Peak-2)/2

$$Meanprofiledepth_{Section} = \frac{\sum_{1}^{n} MeanSegmentDepth_{Segment(i)}}{n}$$

FIG. 3-Standard Method Used for Calculating Mean Profile Depth [9]

2.6 International Friction Index (IFI)

The IFI was developed as a common reference scale for quantifying pavement surface frictional properties. With measures of both macrotexture and friction, it is possible to estimate the IFI for a given pavement section in general accordance with ASTM E 1960, "Standard Practice for Calculating International Friction Index of a Pavement Surface [3]." Guidelines for the implementation of IFI were developed at the "International PIARC Experiment to Compare and Harmonize Texture and Skid Resistance Measurements [12]." IFI is currently being adopted worldwide as the standard skid resistance measure. The IFI consists of two parameters: (1) one that represents the wet friction of a pavement at 60 km/h (F60), and (2) a speed constant of wet pavement friction (S_p).

Measurement of the pavement macrotexture is used to estimate the wet pavement S_p. The wet pavement S_p in km/h is determined from MPD in mm as follows:

$$S_p = 14.2 + 89.7 * MPD \quad (1)$$

The calibrated wet friction parameter (F60) can be estimated from the results of friction testing in accordance with ASTM E 274, using either the standard ribbed tire, as described in ASTM E 501, or the smooth tire, as described in ASTM E 524. The International PIARC Experiment to Compare and Harmonize Texture and Skid Resistance Measurements resulted in a set of regression-based relationships that can be used to transform ASTM E 274 data (FN_{40R} or FN_{40S}) to the IFI, F60 parameter [12].

This relationship, as published in ASTM E 1960 is:

$$F60 = A + B * FRS * \exp[-(60-S)/S_p] + C * MPD \quad (2)$$

where: A, B, and C are calibration constants; and

FRS is the measured friction at some slip speed, S.

If we use FN_{40R} as an estimate of FRS, the calibration constants to be used, as published in ASTM E 1960 are: A = -0.023, B = 0.607, and C = 0.098; and if we use FN_{40S} as our estimate of FRS, A = 0.045, B = 0.925, and C = 0. The resulting F60 and S_p parameters are reported as IFI (F60, S_p).

As noted in *Note 3* of ASTM E 1911, "Standard Test Method for Measuring Paved Surface Frictional Properties Using the Dynamic Friction Tester," results from the International PIARC Experiment to Compare and Harmonize Texture and Skid Resistance Measurements indicated a correlation with the Friction Numbers from ASTM E 274 produced a correlation coefficient (R) of 0.86 [13]. Thus, for demonstration purposes in this paper, it is reasonable to estimate the wet friction of the pavement (F60) from FN_{40} values obtained from the FDOT Pavement Friction Testing Unit, in accordance with ASTM E 274. It is anticipated that calibration of the FDOT friction test data collected in this study, as described in ASTM E 1960 will be performed at a future date as part of a follow-up study. The results of this additional effort will be used to further promote the use of IFI within the FDOT.

3.0 Test Program

This study was initiated in September of 2003 to evaluate the feasibility of enhancing the existing FDOT friction-testing program through the use of non-contact, laser-based sensors. Under a contract with the University of North Florida (UNF) and ICC, a LMI Technologies, Selcom, Optocator 64 kHz laser system was installed on a selected FDOT Pavement Friction Testing Unit, as shown in Figure 4. More specific information related to the specifications and operation of the LMI Technologies, Selcom, Optocator 64 kHz laser is documented in Appendix I.

Five FDOT calibration sections, located in the vicinity of the State Materials Research Park in Gainesville, Florida were tested as part of this initial study. These five calibration sections represent a wide range of surface textures, including both dense-graded and open-graded friction courses common to Florida state roadways. Each of these calibration sections is further divided into five sub-sections.

The tests conducted on each sub-section of each calibration section included: (1) friction testing in accordance with ASTM E 274, using both the standard ribbed tire, as described in ASTM E 501, and the smooth tire, as described in ASTM E 524; (2) non-contact, macrotexture measurement, using the 64 kHz laser system installed on the FDOT Pavement Friction Testing Unit, in accordance with ASTM E 1845; and (3) volumetric macrotexture measurement in accordance with ASTM E 965, “Standard Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique,” more commonly referred to in practice as the “Sand Patch” test [14].

Initial field-testing was conducted within a two-day period to minimize temporal variations in the test data. Follow-up testing was also conducted for verification

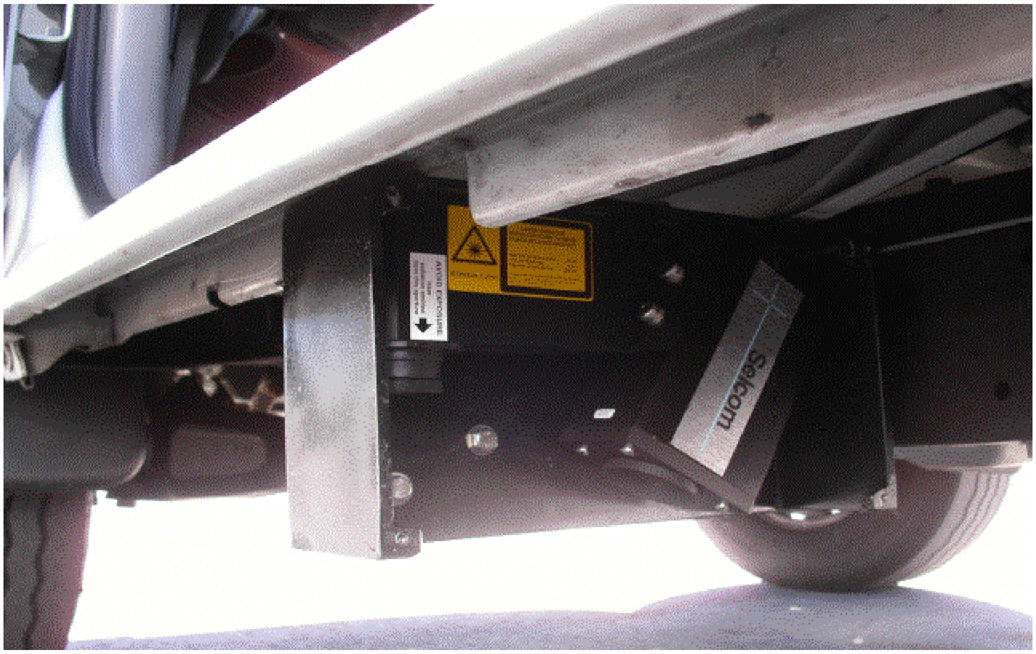


FIG. 4-FDOT Skid Test Unit Instrumented with LMI Technologies, Selcom, Optocator 64 kHz, High-Speed Laser System

FIG. 5-Sand Patch Testing (ASTM E 965) Within the Wheel Lock-Up Zone of a Typical FDOT Calibration Test Section

purposes. Care was taken to ensure that all data was collected in the test wheel path, and within the wheel lock-up zone of each calibration sub-section to control spatial variations in the data. Testing was also performed by the same individuals (FDOT personnel) in order to limit unnecessary operator variability in the resulting data. Each calibration sub-section was tested for Friction Number (FN) at 40 mph (64.4 km/h), once with the ribbed tire (FN_{40R}) and once with the smooth tire (FN_{40S}). Laser macrotexture data was collected at three different speeds of 20, 40, and 60 mph (32.2, 64.4, and 96.6 km/h), and was collected at least twice for each calibration sub-section. Sand Patch tests were also conducted in accordance with ASTM E 965 within each calibration sub-section, and at a frequency of four tests within the wheel lock-up zone of each friction test. Sand Patch testing on a typical section is exhibited in Figure 5.

The above test program strategy was selected in order to provide sufficient data to assess the feasibility of using high-speed, laser-based sensors to quantify the texture and friction characteristics of asphalt pavements. The following results and analyses document the level of accuracy and repeatability of the 64 kHz non-contact, macrotexture measurement, as well as the effects of testing speed gradients. As previously noted, it is anticipated that this technology will lead to a safer, faster and more appropriate method of estimating pavement friction characteristics on high-speed facilities, ramps, and other potentially hazardous sites.

4.0 Test Results

The results of this study are summarized in Table 1 in the form of mean and standard deviation values for the different calibration sections tested. The actual test data are provided in Appendix II. Table 2 provides an example of how typical ASTM E 274 results are transformed to the IFI parameters of F60 and S_p using the relationships and calibration constants developed in the International PIARC Experiment to Compare and Harmonize Texture and Skid Resistance Measurements [12]. The data provided in Table 1 are plotted in Figures 6 through 13 for discussion purposes. The test results are discussed in greater detail in the following paragraphs.

4.1 International Friction Index (IFI)

As noted above, Table 2 provides an example of IFI output for the calibration sections tested in this study. The speed constant (S_p) values reported in Table 2 were transformed from the test-section MPD values using Equation 1. The calibrated wet friction (F60) values were transformed from the ASTM E 274 (FN_{40}) values using Equation 2. As shown in Table 2, the F60 values, as estimated from the standard ribbed tire in accordance with ASTM E 501, are not in close agreement with the F60 values estimated from the smooth tire, as described in ASTM E 524. Presumably, if the calibration constants used in the transformation, Equation 2, were correct, these F60 values would be in agreement. Thus, it is confirmed that FDOT must develop in-house calibration/harmonization constants as described in ASTM 1960 in order to fully implement IFI as a standardized measure of pavement friction. It is anticipated that such calibration/harmonization will be performed at a future date, as part of a follow-up study.

TABLE 1. Summary of Test Results

TEST SECT.	SPEED		FN_{40R}	FN_{40S}	Sand Patch (MTD)		MPD				ETD			
	AVG.	STD.	AVG.	AVG.	AVG. (in)	STD. (in)	AVG. (in)	STD. (in)	AVG. (mm)	STD. (mm)	AVG. (in)	STD. (in)	AVG. (mm)	STD. (mm)
FC-3	**19.6**	0.5	**43.7**	n/a	**0.021**	0.002	**0.043**	0.001	**1.081**	0.029	**0.042**	0.001	**1.068**	0.023
FC-2	**19.9**	0.7	**44.0**	n/a	**0.064**	0.006	**0.142**	0.003	**3.604**	0.076	**0.122**	0.002	**3.087**	0.060
FC-5-OO	**20.0**	0.1	**53.8**	n/a	**0.086**	0.005	**0.163**	0.005	**4.137**	0.132	**0.138**	0.004	**3.513**	0.106
FC-5-GR	**20.1**	0.4	**48.6**	n/a	**0.117**	0.009	**0.209**	0.014	**5.320**	0.364	**0.176**	0.011	**4.460**	0.291
FC-4	**20.3**	0.4	**50.3**	n/a	**0.062**	0.008	**0.056**	0.001	**1.416**	0.019	**0.053**	0.001	**1.336**	0.015
FC-3	**40.0**	0.1	**35.5**	**27.4**	**0.021**	0.002	**0.044**	0.002	**1.121**	0.058	**0.043**	0.002	**1.100**	0.046
FC-2	**40.0**	0.2	**36.7**	**32.5**	**0.064**	0.006	**0.142**	0.002	**3.617**	0.052	**0.122**	0.002	**3.097**	0.042
FC-5-OO	**39.9**	0.3	**35.4**	**33.4**	**0.086**	0.005	**0.165**	0.006	**4.197**	0.143	**0.140**	0.005	**3.561**	0.115
FC-5-GR	**40.0**	0.2	**43.2**	**37.8**	**0.117**	0.009	**0.208**	0.009	**5.274**	0.234	**0.174**	0.007	**4.423**	0.188
FC-4	**40.3**	0.2	**51.4**	**41.4**	**0.062**	0.008	**0.055**	0.001	**1.401**	0.036	**0.052**	0.001	**1.324**	0.029
FC-3	**57.2**	1.0	**30.9**	na	**0.021**	0.002	**0.049**	0.002	**1.239**	0.055	**0.047**	0.002	**1.195**	0.044
FC-2	**59.5**	1.0	**35.7**	n/a	**0.064**	0.006	**0.142**	0.002	**3.610**	0.057	**0.122**	0.002	**3.091**	0.045
FC-5-OO	**59.6**	0.5	**32.9**	n/a	**0.086**	0.005	**0.165**	0.005	**4.187**	0.122	**0.140**	0.004	**3.553**	0.098
FC-5-GR	**58.9**	1.4	**39.6**	n/a	**0.117**	0.009	**0.201**	0.006	**5.100**	0.154	**0.169**	0.005	**4.283**	0.123
FC-4	**59.0**	0.6	**46.1**	n/a	**0.062**	0.008	**0.061**	0.006	**0.061**	0.006	**0.057**	0.005	**1.437**	0.131

TABLE 2. International Friction Index (IFI), F60, S_p.

TEST SECT.	SPEED (km/hr)	FN_{40R}	FN_{40S}	MPD (mm)	Transformed From FN_{40S} and MPD		Transformed From FN_{40R} and MPD	
					Wet Friction, F60*	Speed Constant, S_p (km/h)	Wet Friction, F60*	Speed Constant, S_p (km/h)
FC-3	64.4	35.5	27.4	1.121	26.4	114.8	22.5	114.8
FC-2	64.4	36.7	32.5	3.617	30.5	338.7	22.9	338.7
FC-5-OO	64.4	35.4	33.4	4.197	31.3	390.7	22.1	390.7
FC-5-GR	64.4	43.2	37.8	5.274	35.3	487.3	26.9	487.3
FC-4	64.4	51.4	41.4	1.401	39.6	139.9	32.3	139.9

* Note that the Wet Friction (F60) values reported herein are estimated from Equation 2 using the calibration coefficients of the International PIARC Experiment to Compare and Harmonize Texture and Skid Resistance Measurements [12].

The results of this additional effort will be used to implement the use of IFI within FDOT. It should be noted that the speed constant estimate is the same, regardless of friction test method, as it is calculated exclusively from texture, MPD.

4.2 Mean Profile Depth (MPD)

Figure 6 exhibits MPD, as obtained from the 64 kHz laser, plotted alongside the Mean Texture Depth (MTD), as obtained from the Sand Patch test. The respective 95% Confidence Intervals associated with the mean values are provided to illustrate the relative repeatability of MPD at the variable speeds tested. Note that the overlapping Confidence Interval bars for the MPD obtained at different speeds is a good indication that test speed does not significantly affect the 64 kHz measure of texture between 20 and 60 mph (32.2 and 96.6 km/h). In other words, at a 95% level of confidence, the MPD measured for a given calibration section is statistically the same at 20, 40, and 60 mph (32.2, 64.4, and 96.6 km/h). The MPD, as measured with the 64 kHz laser is highly repeatable at variable speeds.

If we take the results of the Sand Patch test (MTD) as being the correct measure of texture, it is clear from Figure 6 that the 64 kHz laser does not provide an accurate measure of this parameter in all cases except for the FC-4 calibration section. This discrepancy is recognized in ASTM E 1845 by way of the following linear transformation equation:

$$ETD = 0.008 + 0.8*MPD \qquad (3)$$

where ETD is the Estimated Texture Depth in inches, and MPD is also expressed in inches. As noted in ASTM E 1845, the use of Equation 3 should yield ETD values which are close to the MTD values of the volumetric technique according to Test method E 965

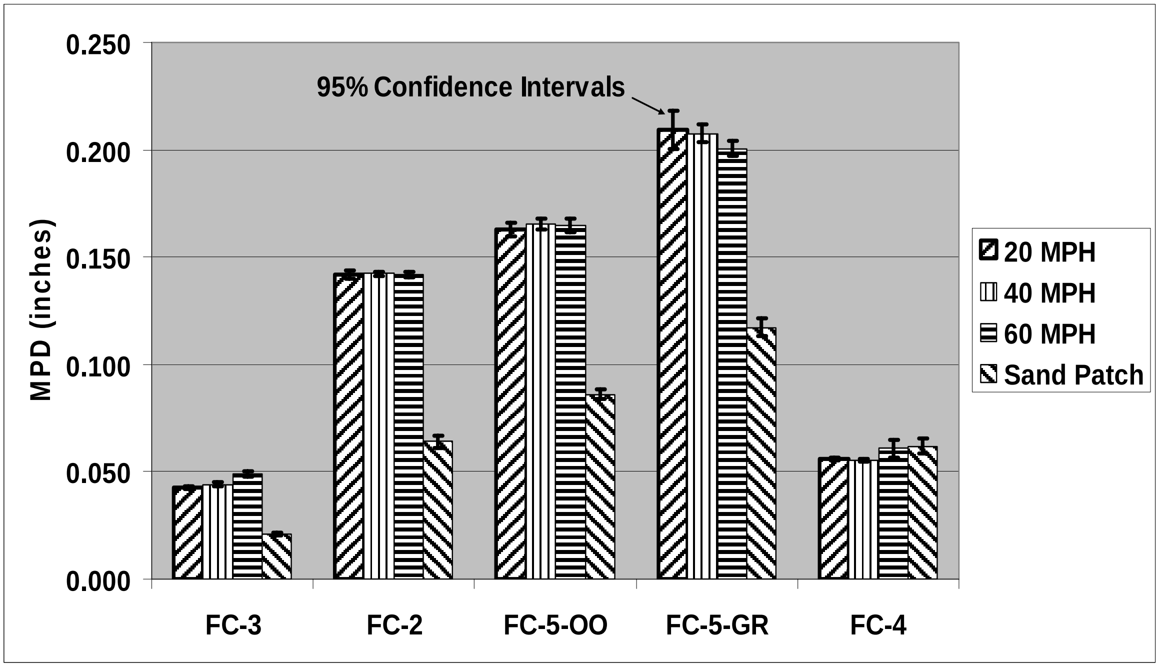


FIG. 6-Mean Profile Depth (MPD) at 20, 40, and 60 mph

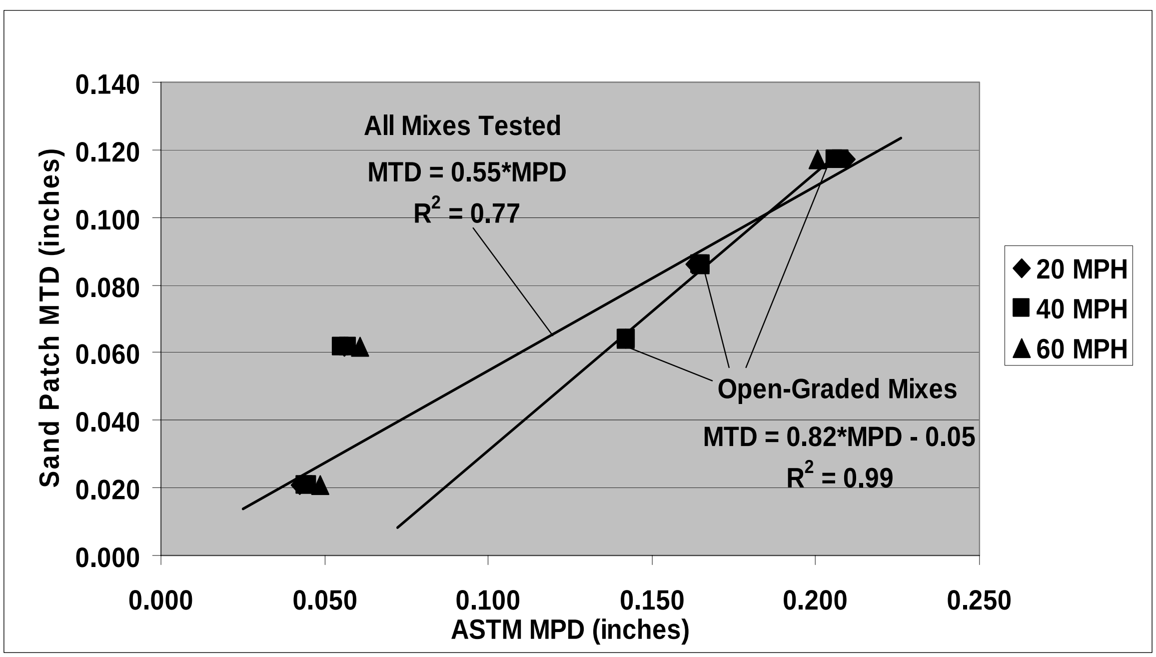


FIG. 7-Mean Profile Depth (MPD) vs. Mean Texture Depth (MTD)

[11]. Thus, it should not be surprising that we see a difference in Sand Patch data and laser texture data in Figure 6.

Linear correlations between MTD and MPD for the calibration sections tested in this study are presented in Figure 7. As noted, the Coefficient of Determination (R^2) for all pavement surfaces tested in this study is relatively strong at 0.77. It is also interesting to note that the resulting linear regression relationship between MTD and MPD is similar to the ASTM E 1845 transformation equation, Equation 3 above, that is:

$$MTD = 0.55*MPD \qquad (4)$$

The 64 kHz laser appears to provide a relatively accurate estimate of MTD.

Another interesting observation from Figure 7 is that there appears to be a much stronger relationship available for the open-graded surfaces, when these sections are considered separately as identified in the figure. The R^2 value obtained for the three open-graded sections tested in this study was found to be 0.99. The resulting linear regression relationship between MPD and MTD for open-graded surfaces is:

$$MTD = 0.82*MPD - 0.05 \qquad (5)$$

again, where MTD and MPD are expressed in inches. This observation suggests that it may be advantageous for FDOT to develop separate relationships for open-graded surfaces and dense-graded surfaces, as the texture of these surfaces is so different. It is envisioned that further testing and analyses related to this hypothesis will be performed at a future date as part of a follow-up effort.

4.3 Friction Number (FN)

Figures 8 through 10 present correlations between Friction Number at 40 mph (64.4 km/h) and Friction Number at 20 and 60 mph (32.2 and 96.6 km/h) for the calibration sections tested in this study. Figure 8 confirms that Friction Number varies with changes in test speed. Figure 9 illustrates that there is a strong linear correlation between FN_{40R} and FN_{60R} for the calibration sections tested in this study (R^2 = 0.95). However, as shown in Figure 10, the best correlation between FN_{40R} and FN_{20R} is not linear (R^2 = 0.08). Based on the data obtained from the calibration sections tested in this study, it appears that the best relationship between FN_{40R} and FN_{20R} is polynomial (R^2 = 0.78).

Figure 11 provides correlations between FN_{40R} and FN_{40S} for the calibration sections tested in this study. As noted, the R^2 values for the correlations between tests conducted using the standard ribbed tire, as described in ASTM E 501, and the smooth tire, as described in ASTM E 524 are relatively strong (R^2 = 0.81). Again, it is noted that an even stronger correlation is exhibited for the non-linear, polynomial relationship (R^2 = 0.99).

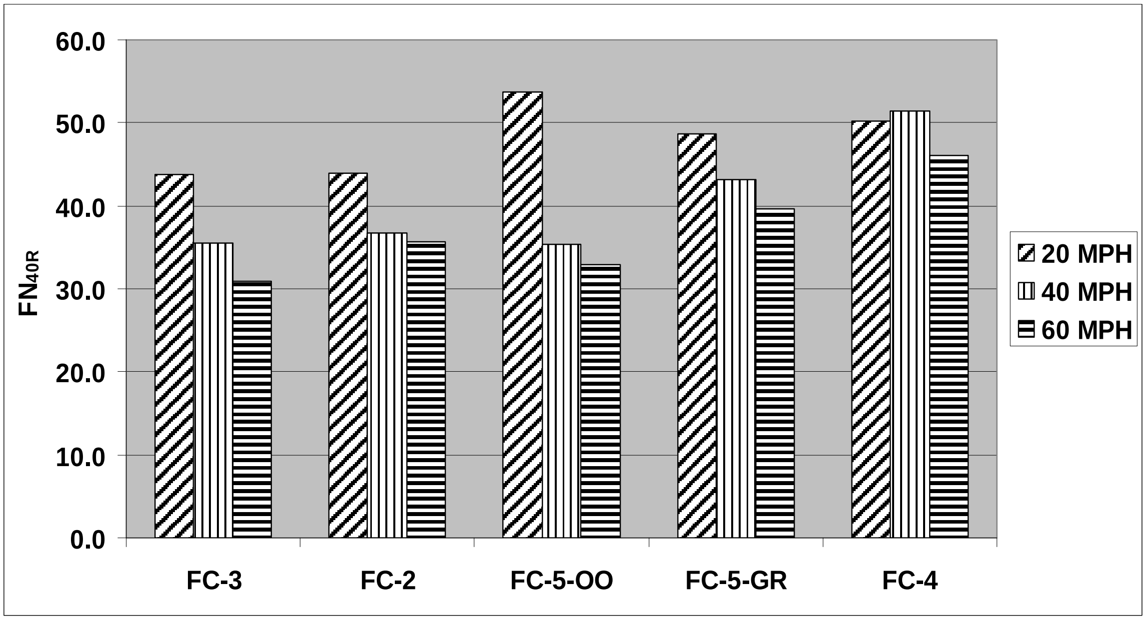


FIG. 8- Mean Friction Number (FN_{40R}) at Different Test Speeds

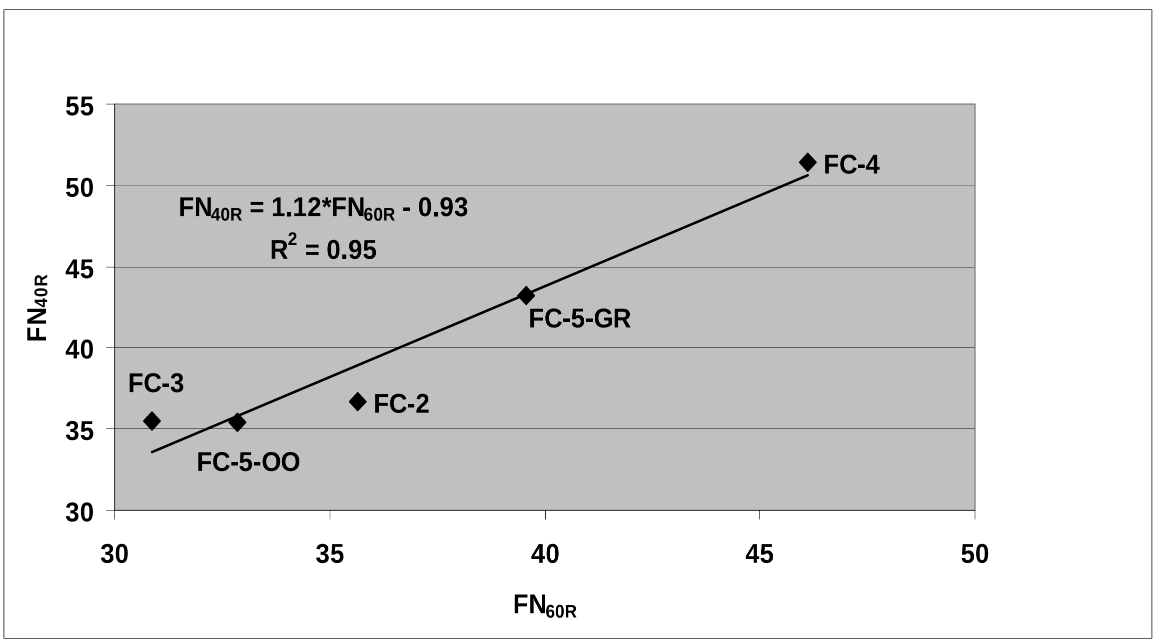


FIG. 9 – Strong Linear Correlation Observed Between FN_{60R} and FN_{40R}

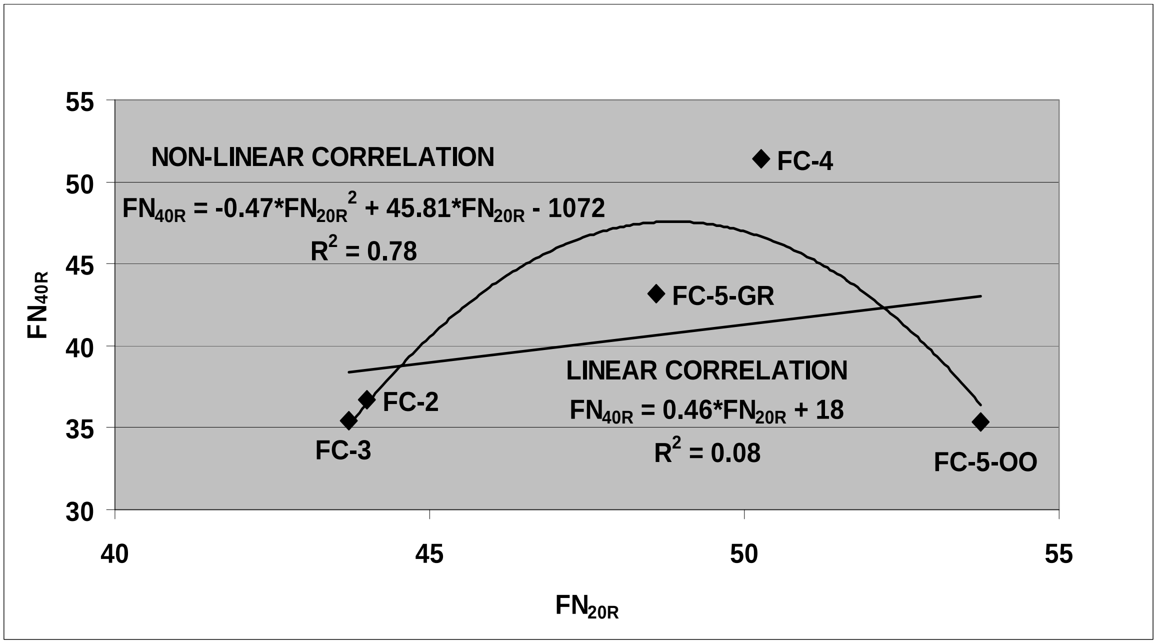


FIG. 10 – Linear and Polynomial Correlations Observed Between FN_{20R} and FN_{40R}

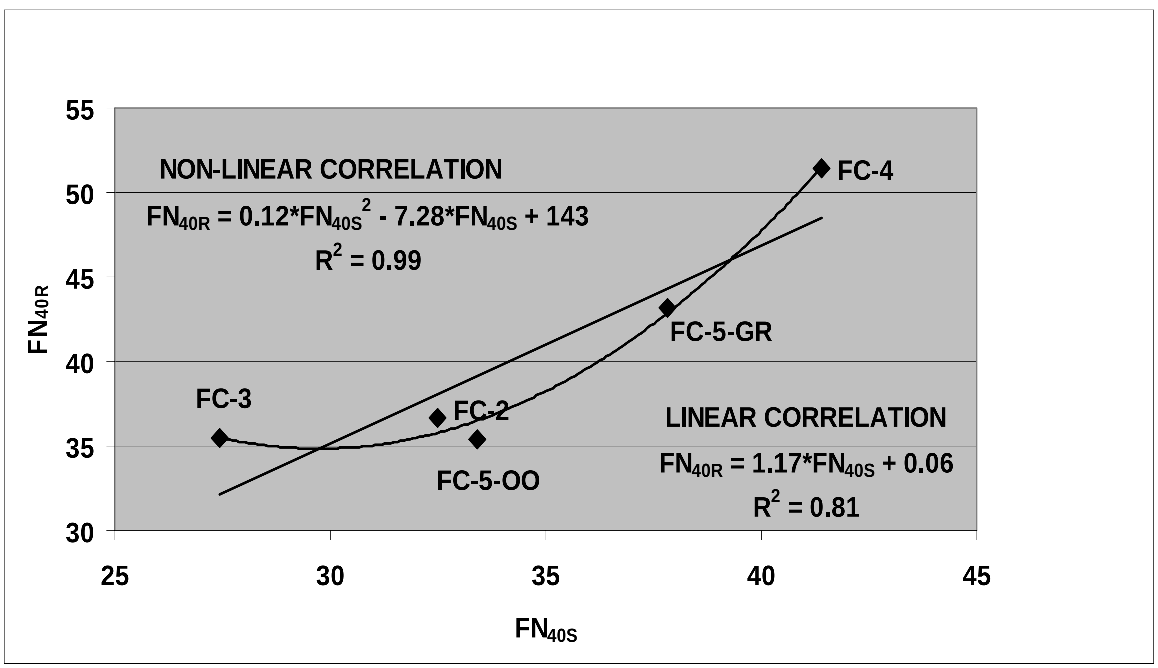


FIG. 11 – Linear and Polynomial Correlations Observed Between FN_{40S} and FN_{40R}

4.4 Estimating FN from MPD

Figure 12 exhibits the observed correlation between MPD and FN_{40R} for the calibration sections tested in this study. Figure 13 exhibits the observed correlation between MPD and FN_{40S}. As noted, the relationships between MPD and FN are extremely weak (R^2 = 0.11, 0.04 and 0.005 for FN_{40R}, at test speeds of 20, 40, and 60 mph, respectively, and R^2 = 0.04 for FN_{40S}). This observation is not surprising when recognizing that pavement texture is only one component of friction. This multi-component concept is clearly recognized with the IFI parameters of F60 and S_p, which provide standardized measures of both texture and friction. Although it is tempting to seek a simple empirical method to estimate pavement friction, the data presented in Figure 12 clearly illustrates that macro-texture is a poor predictor of overall pavement friction.

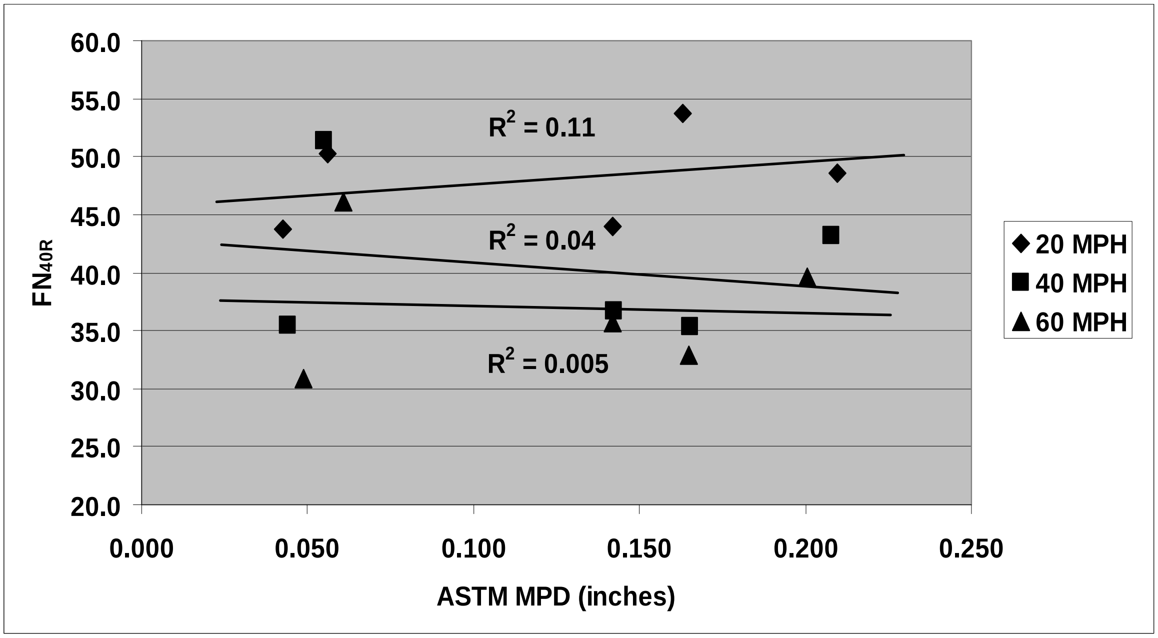


FIG. 12 – Poor Linear Correlations Observed Between MPD and FN_{40R}

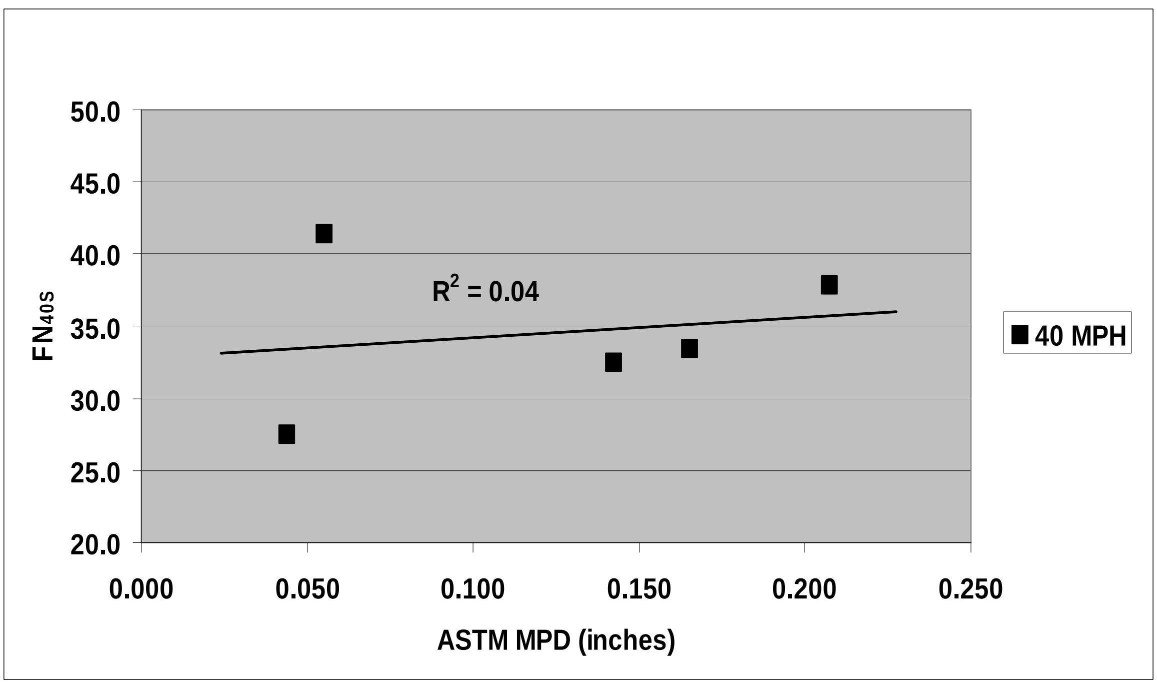


FIG. 13 – Poor Linear Correlation Observed Between MPD and FN_{40S}

5.0 Conclusions

The goal of this study was to assess the feasibility of using high-speed, laser-based sensors to estimate the texture and friction characteristics of asphalt pavements. The results of this study demonstrate that the 64 kHz non-contact, macrotexture measurement system described herein provides a repeatable and accurate measure of MPD. Further, the linear regression relationships between MTD and MPD, as developed from the data obtained in this study (Equations 4 and 5) are similar to the transformation equation provided in ASTM E 1845 (Equation 3). This confirms that the 64 kHz laser can be used to provide a reasonable estimate of MTD.

With a repeatable measure of MPD and wet friction, IFI can be reported in accordance with ASTM E 1960. An example is provided of how FN_{40} data, as obtained from ASTM E 274, and MPD, as obtained from the 64 kHz non-contact, macrotexture measurement system described herein can be transformed for IFI reporting. It is anticipated that a follow-up study will be conducted at a future date for calibration/ harmonization of FDOT friction test data for IFI reporting. This follow-up effort would further promote the implementation of IFI within the FDOT.

In general, macro-texture was found to be a poor predictor of overall pavement friction, as illustrated in Figures 12 and 13. This observation is consistent with the adoption of IFI by ASTM and others. As noted, pavement texture is only one component of friction.

In summary, the results of this study, when fully implemented, will yield a safer, faster and more appropriate method of estimating pavement friction characteristics on high-speed facilities, ramps, and other potentially hazardous sites in Florida.

6.0 Recommendations

As described herein, the results of this preliminary study have demonstrated that reasonable correlations can be developed between friction test data obtained at the standard test speed and data obtained at other speeds. An example of the calculation of IFI is also provided. Full implementation of IFI in Florida will require harmonization of FDOT equipment and methods with reference standards, as described in ASTM E 1960. It is proposed that an expanded test program be conducted to include the following tasks:

- Validate the results of this preliminary study through expanded testing on Florida Roadways.
- Harmonize FDOT equipment and methods with reference standards, as described in ASTM E 1960.
- Recommend practical methodologies/protocols for the use of IFI in Florida.
- Recommend a plan to implement the developed methodologies/protocols.
- Provide training materials on the developed methodologies/protocols.

The primary objective of this proposed expanded study is the implementation of IFI in Florida, thus enabling friction testing to be conducted at variable speeds, for enhanced safety to the traveling public and FDOT personnel.

7.0 References

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8.0 Appendices

8.1 Appendix I

LMI Technologies, Selcom, Optocator 64 kHz Laser User's Manual

LMI

User's Manual

OPTOCATOR

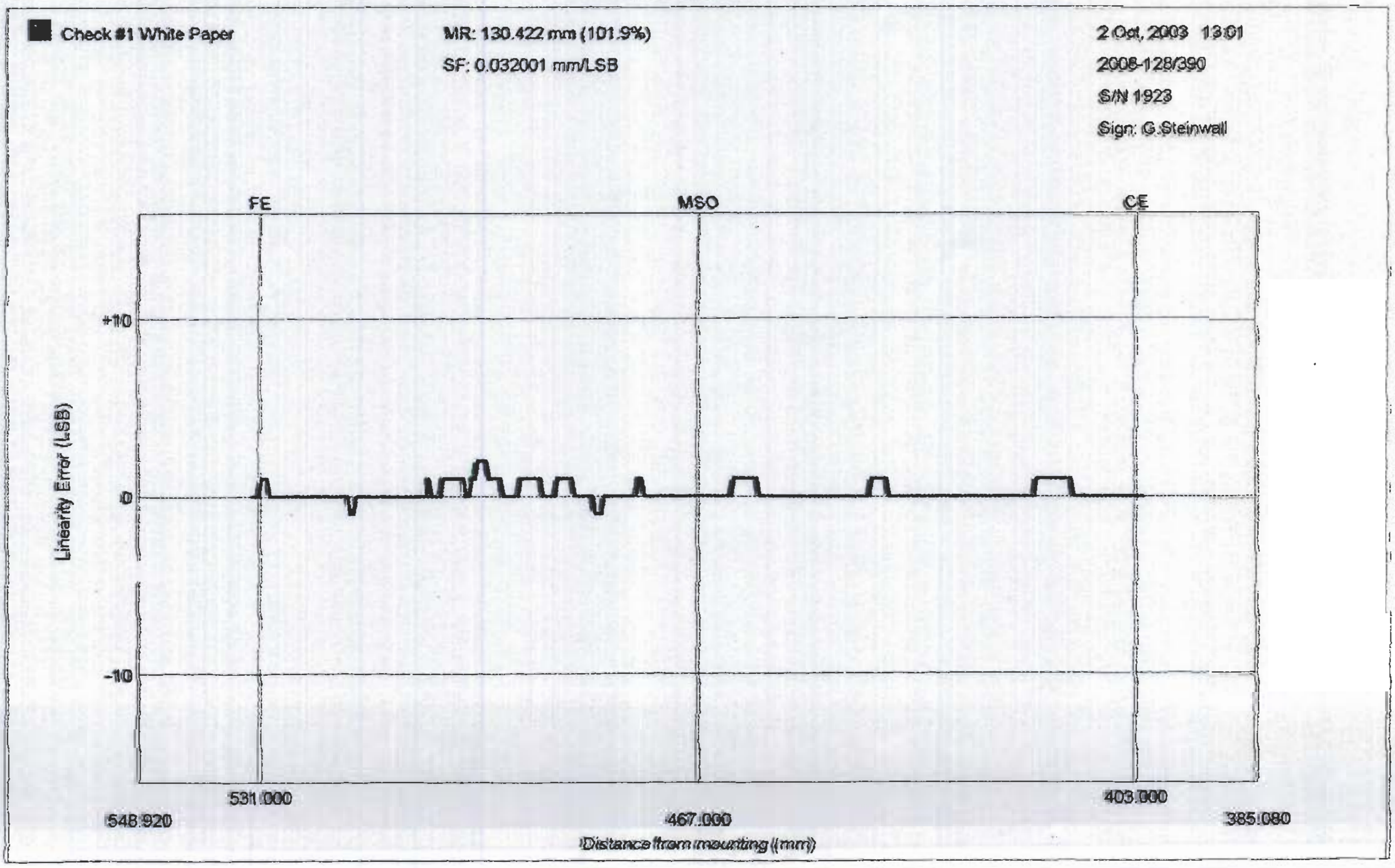
Selcom
LASER MEASUREMENTS

QUALITY RECORD

NOTE: A general description of the Quality Record, as well as explanations for terms and abbreviations, can be found in the Optocator/SLS5000 User's Manual, appendix G.

Sensor Info	Sensor type:	2008-128/390-H	Date:	2 Oct, 2003
	Part number:	813289	Operator:	G.Steinwall
	Serial number:	1923	Signature:	....
Parameters	Measurement Range:	128.0 mm (-0% / +2.4%) 5"	Sampling frequency:	~~64~~ kHz 62,5
	Mounting Stand-Off:	467.0 mm (± 5.0 mm) 18.5"	Bandwidth:	20 kHz
	Scale Factor:	0.032000 mm/LSB (± 1‰)		
	Output(s):	Selcom		
	Special tests:	☐ Not required	☒ Required; have been carried out	
Laser Safety	Max average power:	8,5 mW		
	Wavelength:	655 nm (Visible Red)		
	Safety distance:	9,4 m (according to EN60825 and IEC825)		
	Emission delay:	Laser ON		

Check Error



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Printed in Sweden

1 UNPACKING

The OPTOCATOR system you are using is an optoelectronic device equipped with a laser diode light source.

- Before operating, carefully study the Laser Safety section of this manual and always make sure that eyes are never exposed to direct laser radiation or to mirror or mirror like reflections.
- Your OPTOCATOR is equipped with two lens systems. One lens on the camera and one lens behind the aperture of the light source. All OPTOCATORs have protection glasses in front of the lenses. The camera lens is in some cases fitted with a protection glass that can be replaced should it be damaged.
- Before operation, make sure that the lenses or protection glasses are clean and undamaged, see section 6 for cleaning instructions.

Content of delivery (see section 2.2 for identification of parts) :

- Sensor head.
- Probe Processing Unit.
- OPTOCATOR User´s Manual.

  At delivery the sensor head and the probe processing unit are detached.

Connection of the OPTOCATOR :

- Remove the protection bag surrounding the connector.

  Be careful not to touch the pins of the connector : laser failure may occur !
- Connect the sensor head and the probe processing unit (see section 4.1).
- Mount the OPTOCATOR (see chapter 4) and connect other cables.

2 INTRODUCTION

This manual will give you a step by step practical introduction to the OPTOCATOR system. The intention is to ensure that the OPTOCATOR provides you with the best possible performance.

Please study this manual thoroughly before you start up the system and use it later as a reference and as a guide for maintenance and troubleshooting.

Section 3 is a very important chapter on "Laser Safety" that should be read before you power up the OPTOCATOR.

If during any period of start up or usage a question arises, please contact SELCOM at any of our addresses listed above, or your local distributor.

2.1 Definitions

Terminology:	*Definition:*
CD	Clearance Distance. The minimum distance between the OPTOCATOR and the close end of the measurement range.
CE	Close End. SO - MR/2. The highest OPTOCATOR value (in counts).
FE	Far End. SO + MR/2. The lowest OPTOCATOR value (in counts).
MR	Measurement Range. The detectable distance symmetrically around the Stand Off distance (ref SO).
MSO	Mounting Stand Off. The distance from the rear mounting surface to the center of the measurement range.
OIM-I	OPTOCATOR Interface Module without laser safety panel.
OIM-II	OPTOCATOR Interface Module with laser safety panel.
PPU	Probe Processing Unit.
SO	Stand Off. The distance from the front aperture of the light source to the center of the measurement range.
SSP	SELCOM Signal Processor.

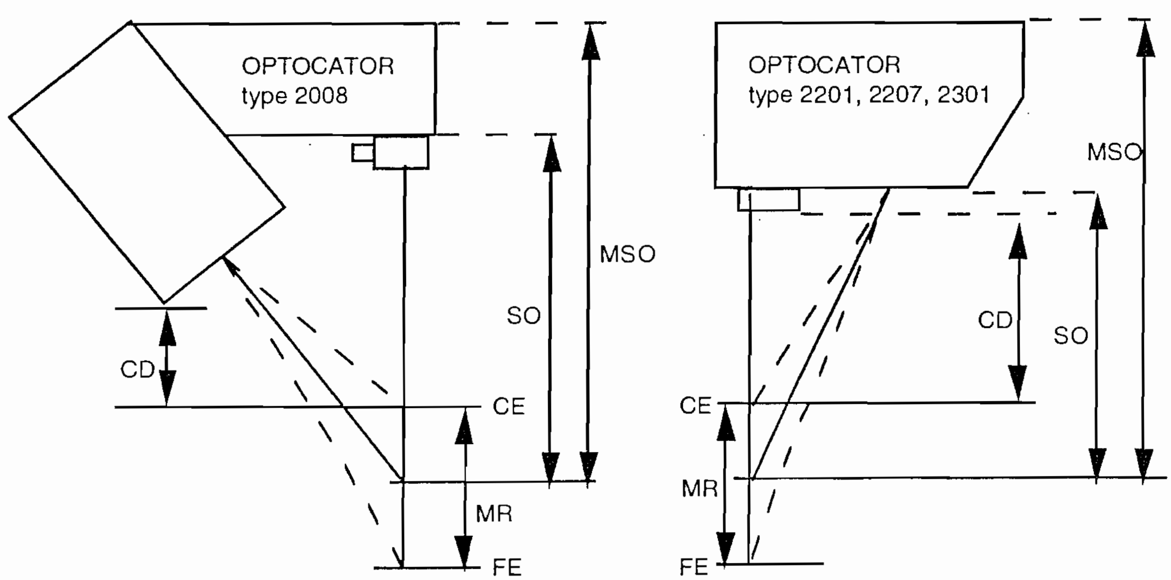


Figure 1: Definitions of CD, CE, FE, MR, MSO and SO

Terminology:	*Definition:*
Inaccuracy:	The difference between the average of a long series of repetitive measurement and the true value of the specimen measured.
LSB	Least Significant Bit. The smallest digital bit in the data stream from the Optocator. 12 bit data.
Non linearity:	Peak deviation from a best-fit straight line expressed as a percent of MR.
Precision:	The variability of measurement error. Includes repeatability and reproducibility.
Repeatability:	The variability of the measurement error **within** a single measurement system. Individual measures over the same parts for the same gauge system. Repeatability approx. Equal to the noise.
Reproducibility	The variability of measurement error between measurement systems.
Resolution:	The smallest increment available from the measurement process.
Response time:	Time required, after application of a step input, for the output to settle and remain within a specified error band around the final value.
Temperature Stability:	A measure of the dependability, or consistency, of the measurement over temperature.
True value:	The correct value of the characteristic being measured.

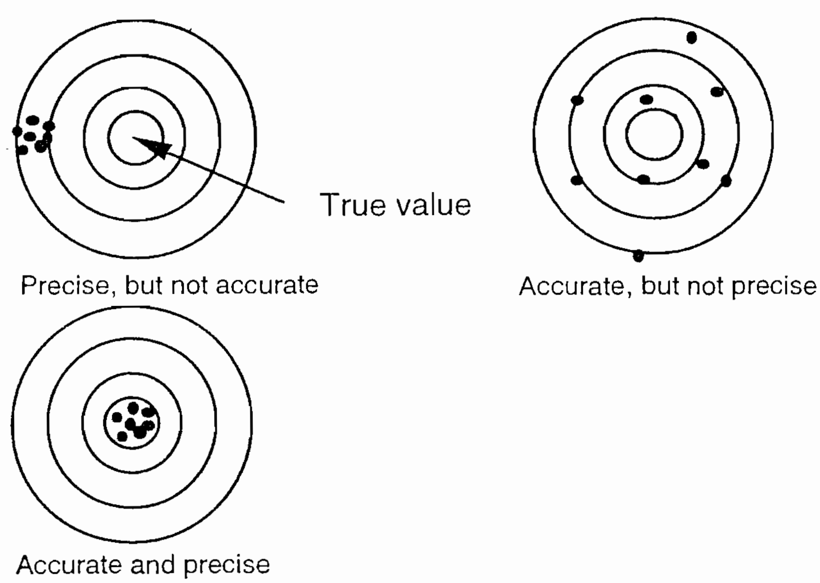


Figure 2

2.2 Identification of hardware

The OPTOCATOR consists of two major parts :

1. The OPTOCATOR head (Sensor head).
2. The Probe Processing Unit, PPU.

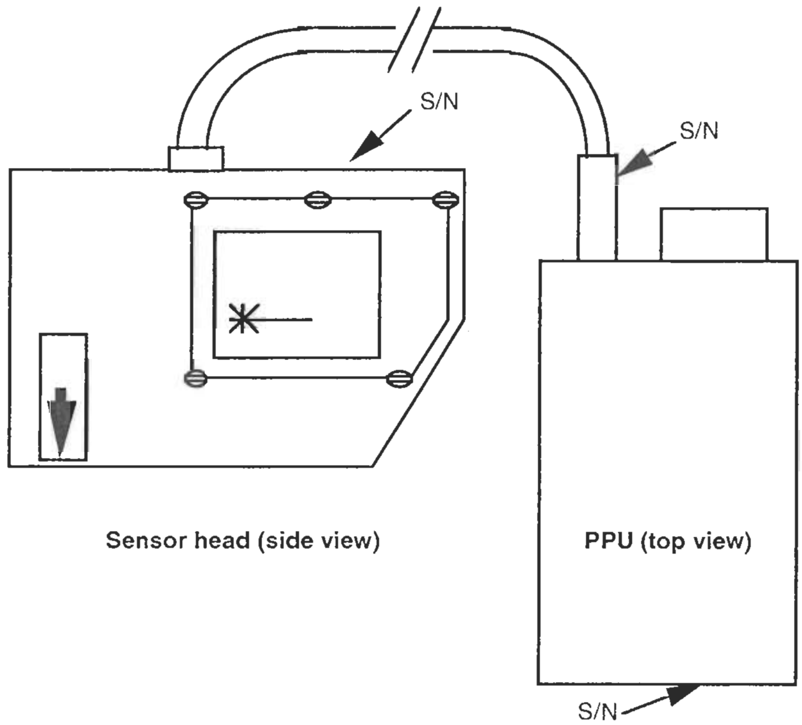


Figure 3: Optocator, parts

The OPTOCATOR head contains the laser light source, the light receiver and a preamplifier.

The PPU contains the signal processing part of the OPTOCATOR.

The OPTOCATOR head and the PPU is connected with a cable detachable on the PPU side (some OPTOCATOR models are equipped with an exchangeable cable).This cable is normally a 1.5 meter cable but other lengths may be supplied. The cable length must remain as delivered or linearity may be influenced.

These two units are NOT interchangeable with other OPTOCATOR units otherwise laser failure may occur.

The OPTOCATOR head, the connector end of the cable and the PPU is marked with the serial number (**S/N**) of the OPTOCATOR.

2.3 Principal of operations

The OPTOCATOR measures by means of infrared or near infrared light and some models have visible light. Laser intensity output is controlled by the PPU to maintain a constant level of light on the detector. The principle of optical triangulation permits measurement even when the light source is other than perpendicular to the surface measured. The possible angle of incidence will depend on the material to measure and on surface geometry, ref. chapter 4.3.

When the beam hits a surface, a scattered reflection will occur. This light spot on the surface is viewed by a camera mounted inside the OPTOCATOR head in the same way a human eye would do with visible light (e.g. a flash torch on a wall).

The image of this spot is focused on a position sensitive detector. By means of analog processing the sensor determines the location of the center of gravity of the image, and uses this information to determine where the actual spot (and the target) is. See figure below.

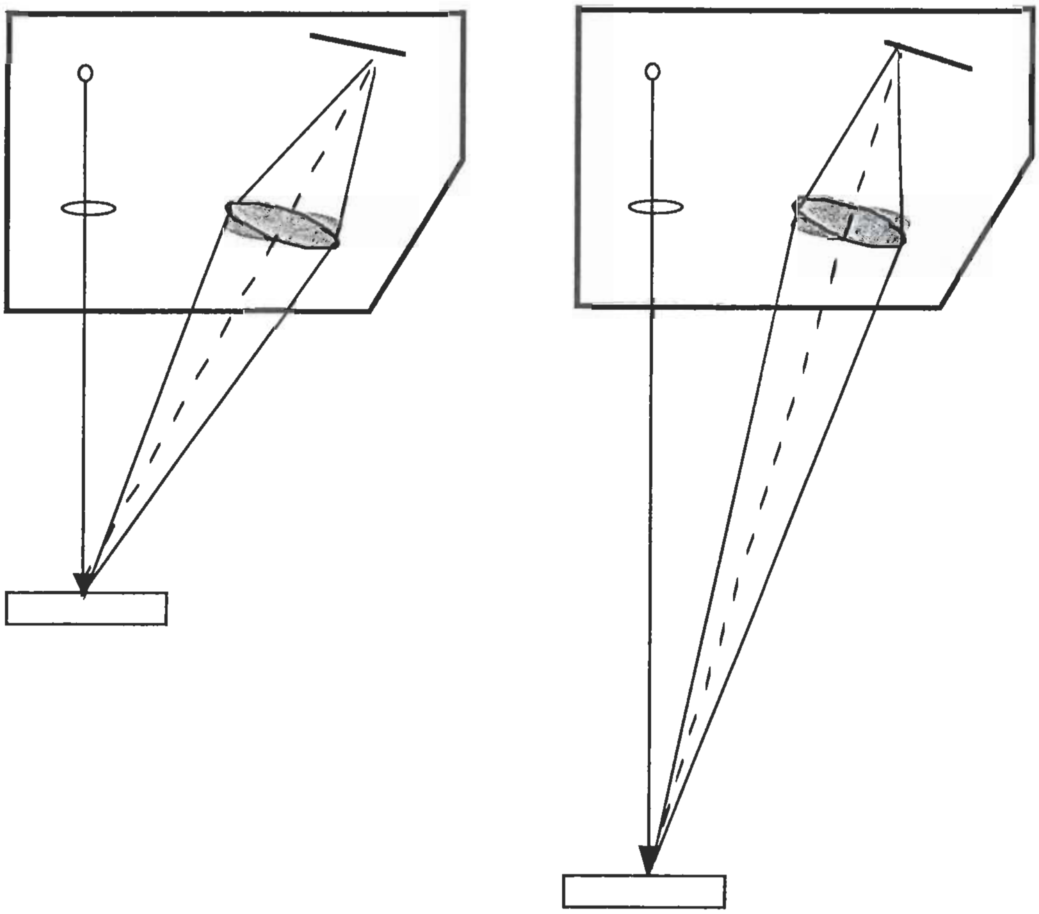


Figure 4: Principe of Optical Triangulation

See also chapter 8 OPTICAL TRIANGULATION.

2.4 Outputs

Serial interface :

16 bit serial synchronous interface consisting of :

- 12 bit measurement data.
- 3 bit valid/invalid signal.

See chapter 9 TECHNICAL SPECIFICATION for details.

The "Invalid bit" is the OPTOCATOR ´s general alarm if something is wrong. This bit will be set on three different conditions:

1. No object is within the MR.
2. Amount of light received on the detector is too small to make a full specification reading possible. This may occur due to obstruction, angle of incidence, dirt on lenses or simply the surface condition.
3. Amount of light received on the detector is too high.
4. Invalid may turn off well outside of the MR due to false measurement ranges. Section 4 describes this phenomenon as well as other practical aspects of how to set up the system.

3 LASER SAFETY

The light source in the OPTOCATOR is a laser diode. This laser diode meets the demands on the light source that gives the OPTOCATOR its good measurement properties.

These demands are:

- High power output capability.
- High modulation ability.
- Small light spot.

The OPTOCATOR is classified as a class 3B laser product.

Class 3B

Class 3 B Lasers which can damage the eye and in some cases skin by direct exposure to the beam. Diffuse reflected radiation is generally, but not always innocuous. Most surfaces give rise to a certain proportion of directed reflected energy - for infra-red radiation the proportion of directed reflection can be very large from a metal surface which appears to the eye to be matte

Class 3B deals with a laser power range from 1 mW to 500 mW. The normal maximum output from the OPTOCATOR is 20 mW.

This section describes the technical safety features which are built into the OPTOCATOR and general technical details regarding the laser that apply to all OPTOCATORs. For calculations of minimum safety distance and products specific details, please contact SELCOM!

The OPTOCATOR is classified as a laser product class 3B according to the following standards :

Standard:	*Can be ordered from:*
HEW Publication (FDA) 79-8035	Superintendent of Documents U.S. Government Printing Office Washington, DC 20402 Stock No. 017-012-00274-9
SS-EN 60825	SIS Box 3295 S-103 66 STOCKHOLM Telephone : +46-(0)8-613 52 00 Telefax : +46-(0)8-11 70 35 Cost : 1500 SEK (February 1994)

You may also contact your closest SELCOM representative for further information on your product.

In accordance to the current safety standards, the OPTOCATOR is equipped with the following safety features :

- A visible warning signal.
- Delayed emission of the laser beam (At Power ON or Laser ON).
- Key controlled master switch (when using SSP or OIM-II).
- Connections for remote control (when using SSP, OIM-I or OIM-II).
- Warning labels.
- Emission shield.

3.1 Visible warning signal

The OPTOCATOR is equipped with a visible warning signal which indicates that laser light is being emitted.

3.2 Delayed emission of the laser beam

Emission of the laser beam is delayed by a few seconds after the warning signal is illuminated, in order to give personnel time to take action to avoid exposure.

3.3 Key controlled master switch

A key controlled master switch must be implemented by the user to conform with the safety standards. The key should only be removable when the switch is turned off. The SSP and the OIM-II board are equipped with such a key controlled master switch.

3.4 Connections for remote control

The SSP and the OIM boards are provided with connections which permit the laser to be remotely controlled without affecting the other electronics.

It is **strongly recommended** that the remote control is used so that the laser is on only when measurements are taking place. This will minimize accidental exposure to operators and other personnel. All other electronics remain energized assuring that the measurement results are not affected when the laser is turned on.

The principle of the SSP and the OIM remote control is shown in the diagram below (for details see SSP or OIM manual).

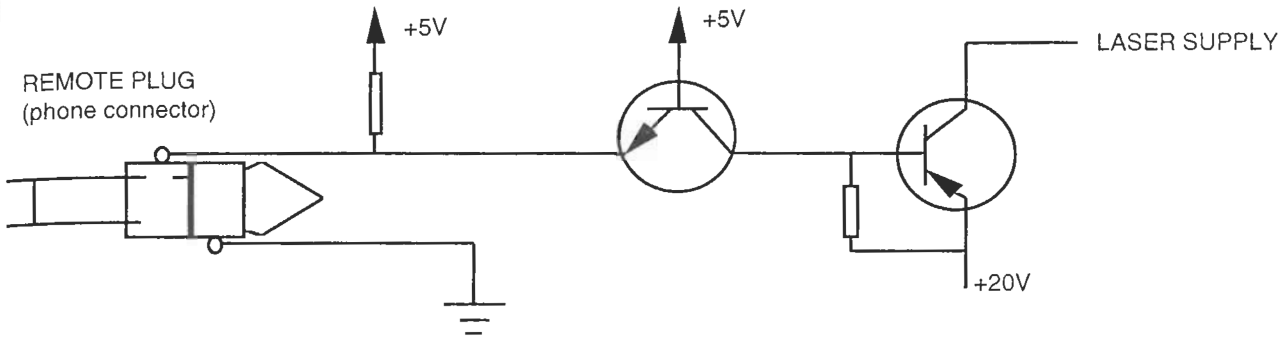


Figure 5: The principle of the SSP and OIM remote control

3.5 Warning labels

All OPTOCATOR ´s are fitted with the following labels:

- Warning label.
- Aperture label, indicating the opening through which the laser beam is emitted.
- Type approval label.
- Identification label.

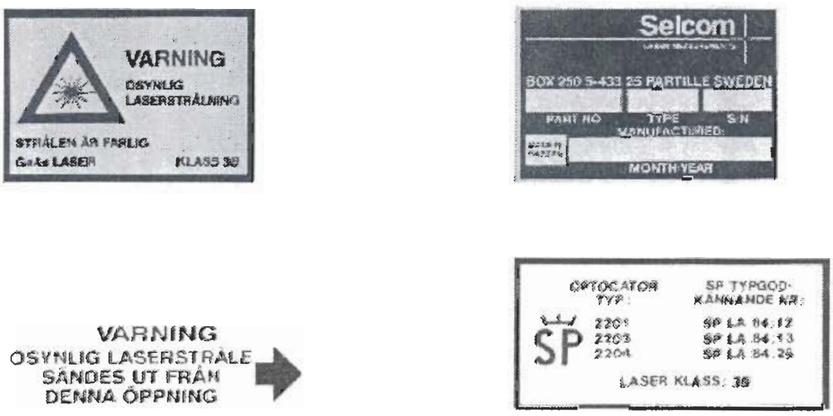


Figure 6: Swedish labels (European style) :

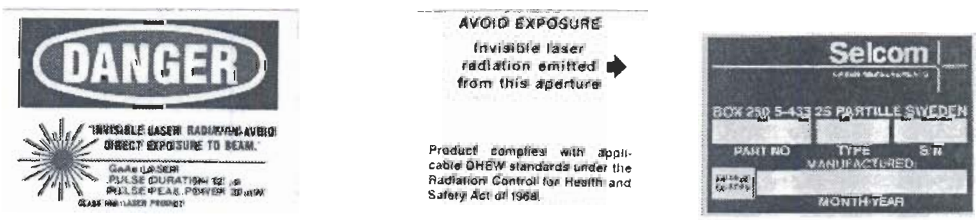


Figure 7:American labels :

3.6 Emission shield

The opening from which laser light is emitted is provided with a mechanical flap which can be closed during servicing.

Caution: Attempts to repair the sensor may result in hazardous radiation exposure. The user should not attempt to repair the unit without first contacting Selcom AB.

In applications where there is a risk that personnel can be present within the safety distance to the OPTOCATOR, it is recommended to wear laser protection goggles.

Technical specification for the lasers used in the OPTOCATOR :

	Infrared	Near infrared	Visible
Wavelength	820	780	670 nm
Repetition frequency	16, 32, 64	16, 32, 64	16, 32, 64 kHz
Pulse length	31.5, 15.6, or 7.8	31.5, 15.6, or 7.8	31.5, 15.6, or 7.8 µs
Duty cycle	50	50	50 %
Max. Power/pulse	40	40	10 mW
Max. Average power	20	20	5 mW
Working power/pulse	10	10	6 mW
Average working power	5	5	3 mW

Pulse energy for each pulse is calculated to be :

Infrared or Near infrared	Max. Power/pulse 40 mW	Working power/pulse 10 mW
16 kHz	1.260 µJ	0.315 µJ
32 kHz	0.624 µJ	0.156 µJ
64 kHz	0.312 µJ	0.078 µJ

Visible	Max. Power/pulse 10 mW	Working power/pulse 6 mW
16 kHz	0.315 µJ	0.189 µJ
32 kHz	0.156 µJ	0.094 µJ
64 kHz	0.078 µJ	0.047 µJ

The light from the laser beam passes a lens which normally focuses the light at the center of the measurement range (at SO).

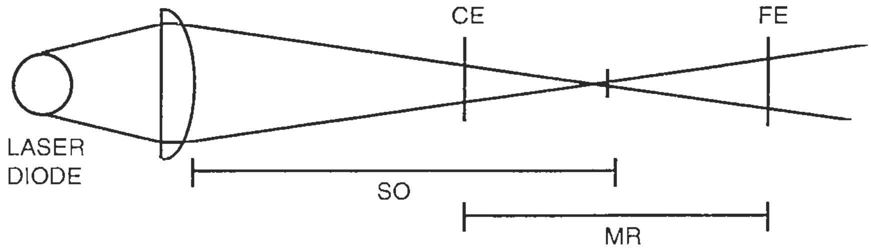


Figure 8: Laser-spot focus at Stand-off distance

Factors which effect the safety distance (nominal ocular hazard distance) are power output, beam divergence and sampling frequency.

For the OPTOCATOR the following applies:

1. The Maximum Permissible Exposure (MPE) value for one single pulse is exceeded when maximum power is sent out from an infrared or near infrared laser system (40 mW, 820/780 nm).
2. The MPE value for a single pulse in a train of pulses at average working power is exceeded.

Do not look into the laser beam (front aperture of the OPTOCATOR) without convincing yourself that the distance is greater than the minimum safety distance.

Protective clothing is not needed. The OPTOCATOR is not powerful enough to burn skin.

4 INSTALLATION

The check list below is a summary of some points of importance we want you always to consider before and during installation of a new system.

NOTE: **It is possible during installation to get unintentionally exposed to laser light. Take extra care and be sure not to look into the laser aperture of the OPTOCATOR unless you are certain that the laser beam is turned off. Tools that are used during installation may give mirror like reflections.**

The laser beam of the OPTOCATOR can not burn skin.

1. Make a careful visual inspection of the entire system. Be sure you have no mechanical damages. Check conditions of cables. Check all connectors.
2. Ensure that the OPTOCATOR head is matched with the right PPU. The serial numbers must be identical (see section 2.2).
3. Be sure that you have done a proper mechanical installation. This is of special importance when installing a dual sensor system (see section 4.2).
4. Ensure that the sensor(s) you use is (are) matched to the application.
5. Check that you do not get secondary reflections from objects close to the measurement object (see section 4.3-4).
6. When installing a dual sensor system for measurement on non-transparent material be sure that the two sensors cannot see each others light source. This is easily identified since it produces a beating on the output at about 1 Hz. For semi transparent material, special versions of the OPTOCATOR are available.
7. Use an IR-viewer or an IR-plate to detect the light spot (to get maximum light, cover the receiver opening). The near infrared laser is easy to detect when reflected from a blue colored target, e.g. a piece of blue paper.
8. Make calibrations at two different positions inside the measurement range to avoid systematic errors caused by the structure of the surface.
9. A calibration piece should have the same surface or a surface similar to the target surface. E.g. calibrating on a piece of paper when measuring on rubber.

If you have an incorrect behavior of the OPTOCATOR system, the troubleshooting section (6.3) of this manual may give you some help. If you still have problems or an incorrect behavior, please contact SELCOM.

4.1 Electrical connections

The output signals from the OPTOCATOR are available on connector P10 :
OPTOCATOR type 2008, 2201, 2204, 2207, 2301

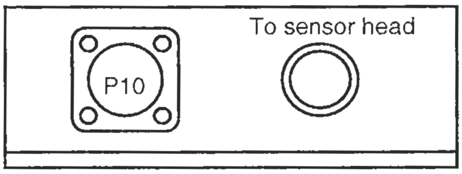


Figure 9: PPU connector

The output connector P10 (14-pin Cannon MSE connector) is located on the PPU.

A	NC (Note)
B	DATA-inverse
C	GND (- Laser supply)
D	+20 VDC
E	GND
F	+15 VDC
G	+ Laser supply
H	DATA
I	NC (Note)
J	NC (Note)
K	NC (Note)
L	CLOCK
M	-20 VDC
N	CLOCK-inverse

Note : These pins are reserved for OPTOCATOR temperature measurement, laser intensity measurement etc.

4.1.1 Power Supply Information

Input voltage	+20 V (±1V) max. 100 mA (D)
	- 20 V (±1V) max. 100 mA (M)
	+15 V (±4V) max. 160 mA (F)
	+18 V (±3V) max. 150 mA (G)

11-pin Fischer connector (to sensor head)

IMPORTANT :

Do **not** connect anything but the sensor head to this connector or laser failure may occur.

4.1.1.1 Junction box type 20008

The junction box may be used to minimize the number of cables used in a dual OPTOCATOR installation.

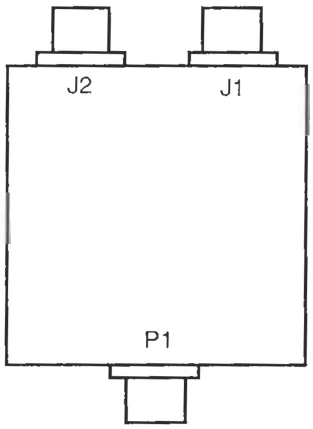


Figure 10: Junction box overview

Connector J1 : Cable to/from OPTOCATOR no 1 (cable type 20003).

Connector J2 : Cable to/from OPTOCATOR no 2 (cable type 20003).

Connector P1 : Cable to/from interface unit (OIM boards, SSP).

Pin configurations :

Pin no	Connector J1, J2	Connector P1
A	NC (Note 1)	DATA (No 2)
B	DATA-inverse	DATA-inverse (No 1)
C	GND (-diode)	GND (-diode)
D	+20 VDC	+20 VDC
E	GND	GND
F	+15 VDC	+15 VDC
G	+ Laser supply	+ Laser supply
H	DATA	DATA (No 1)
I	NC (Note 1)	CLK-inverse (No 2)
J	NC (Note 1)	DATA-inverse (No 2)
K	NC (Note 1)	CLK (No 2)
L	CLK	CLK (No 1)
M	-20 VDC	-20 VDC
N	CLK-inverse	CLK-inverse (No 1)

Note 1 : These pins are reserved for OPTOCATOR temperature measurement, laser intensity measurement etc.

Note 2 : Pins D, E, F and M are input voltages from the interface unit to the OPTOCATOR. Pin G is the laser supply input (+20 VDC) from the interface unit to the OPTOCATOR.

4.2 Mechanical installation

The OPTOCATOR must be mounted rigidly in such a way that neither thermal expansion of the fixture nor external forces may influence its position. Otherwise the accuracy of the system will be affected and frequent re calibrations of the system may be necessary. Calibrate the system as often as possible to avoid influence of mechanical fixture drift due to time and temperature.

Make sure that the optical path is not obstructed.

NOTE: **It is possible during installation that unintentional exposure to laser light may occur take extra care not to look into the laser aperture of the OPTOCATOR unless you are certain that the laser beam is turned off. Tools that are used during installation may give mirror like reflections. If possible wear protective goggles.**

The laser beam of the OPTOCATOR can not burn skin.

4.2.1 For a single OPTOCATOR system

The distance between the OPTOCATOR and the reference plane must not be changed.

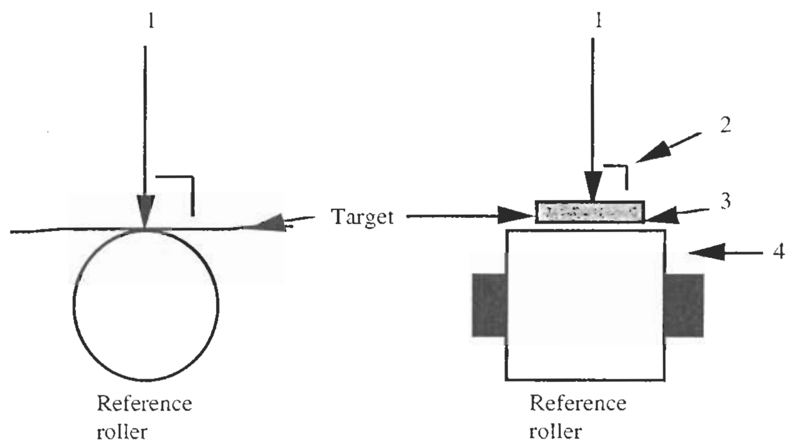


Figure 11: Measurement against the reference plane

1. Laser beam
2. If the incoming laser beam is not perpendicular to the measured surface, compensation for the angle may be necessary.
3. Good contact between the reference surface and the measured material is important.
4. Eccentricity of a reference roll may cause variation in the thickness value. Keeping track of the roll while performing multiple calibrations may solve this problem.

4.2.1.1 For a dual OPTOCATOR system

The distance between the two OPTOCATORs must not be changed, between calibration and measurement.

The accuracy of a dual OPTOCATOR system for thickness measurement is highly dependant on laser beam adjustment of the two sensors. It is necessary to have the two laser beams concentric through the entire measurement range. In the left figure below, the thickness will decrease when the measured object is tilted as in the figure and increase (more than correct) when tilted the other way. In the right figure the thickness of the measured object will increase for any tilt angle.

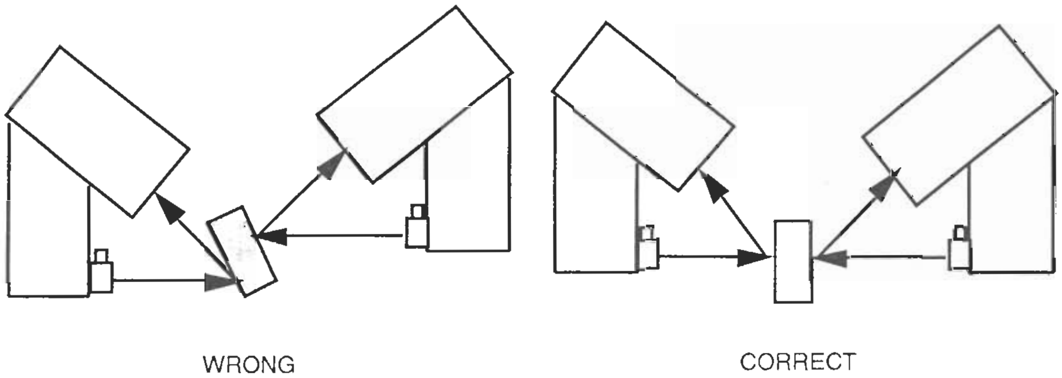


Figure 12: Installation example : Dual sensor thickness measurement

Useful equipment :

IR-viewer.

Piece of cardboard paper (about 0.5 x 100 x 100 mm, preferably blue).

Piece of non transparent material

(about 5 x 100 x 100 mm, with even thickness).

Horizontal spirit level.

1. Sensor 1 is mounted in its fixed position. Use the horizontal sprit level. Make sure that the mechanical flap in front of the laser aperture is in the closed position.

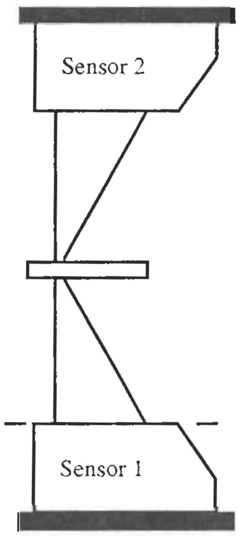


Figure 13: Illustration of how to mount the sensor

2. Sensor 2 should be loosely mounted, not fixed. The sensor should be turned off with the mechanical flap open.
3. Turn sensor 1 on. Cover the receiver aperture of sensor 1 to make the sensor output maximum laser intensity. Open the mechanical flap.
4. Adjust sensor 2. The light spot from sensor 1 must fall on the laser aperture of sensor 2 as concentrically as possible.
5. Turn sensor 1 off and leave the mechanical flap open.
6. Secure the position of sensor 2 (not finally).
7. Cover the receiver aperture of sensor 2 to make the sensor output maximum laser intensity.
8. Turn sensor 2 on. Adjust sensor 2 by tilting it only. The light spot from sensor 2 must fall on the laser aperture of sensor 1 as concentrically as possible. Sensor 2 can be tilted by carefully loosening some bolts and placing thin shims between the OPTOCATOR and the mounting surface.
9. Turn sensor 2 off. Fix its position finally.
10. Remove the covers for the receiver apertures.

The sensors should now be correctly mounted. A control procedure is described on the next page.

The following control procedure can be used to verify that an installation is correctly made or to check for mechanical changes in the mounting structure:

1. Cover the receiver apertures of sensor 1 and 2 to make the sensor output maximum laser intensity.
2. Turn sensor 1 and 2 on.
3. Put the piece of cardboard paper in the measurement range. Make sure by moving the paper along the laser beams that they coincide everywhere between the sensors. If an infrared (820 nm) laser is used, the IR-viewer is necessary to see the light spots. A near infrared (780 nm) laser can be seen without the help of an IR-viewer (especially on a blue color).

Since the cardboard paper is semi transparent for infrared light, the light control circuits of the two OPTOCATORs will interfere. This is noted as a variation in the light intensity of the spot on the paper. This phenomenon will not occur when using special designed sensors for semi transparent materials.

4. Put the piece of non transparent material in the measurement range. Try to keep it as perpendicular to the laser beams as possible. If the sensors are correctly aligned you will note an increase of the thickness when you tilt the plate. A decrease of the thickness value is an indication that the sensors are misaligned.

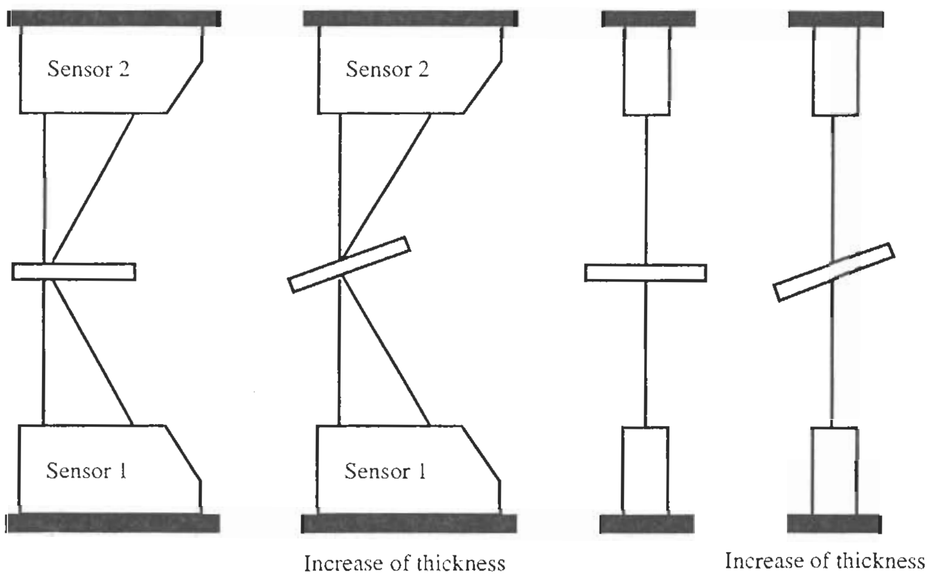


Figure 14: Illustration of item 4 above

Avoid set-ups where the two sensors can see each other when they are supposed to measure. A set-up as described in the left figure will produce a variation in the output value at approximately 1 Hz. See also section 4.3.1.

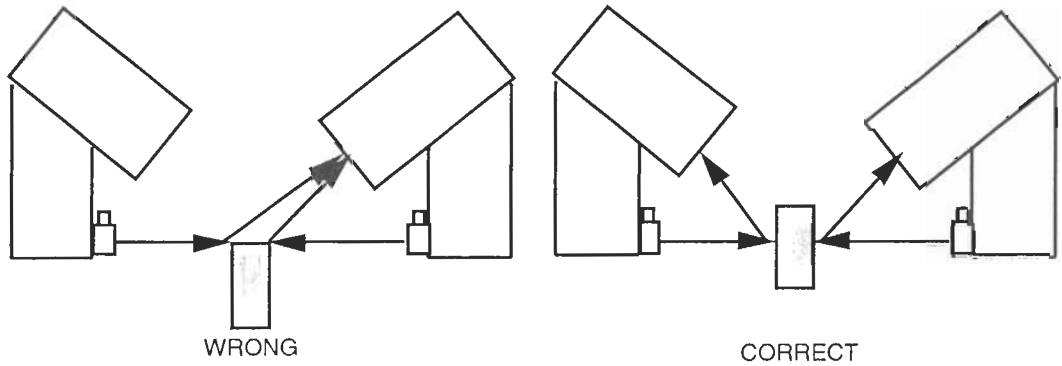


Figure 15: Example : Dual sensor thickness measurement

4.3 Hints for measurements

The OPTOCATOR is designed to give a true and dependable measurement for a vast range of materials, surfaces and speed of target/surface.

4.3.1 Sensor features

All sensors :

Very high speed of light power control.

Dynamic range of light power output extremely wide,

from nanowatts to 5 mW.

Selected before production :

- Bandwidth of position data from 2 kHz to 20 kHz.
- Sampling rate from 16 000 to 64 000 times per second.
- Laser spot down to diam, 0.2 mm.

Some materials or surfaces requires some considerations and advises to get the best possible performance.

The target characteristics can be structured into:

1. Material.
2. Surface texture.
3. Temperature of the material.
4. The geometry of the material.

4.4 Material

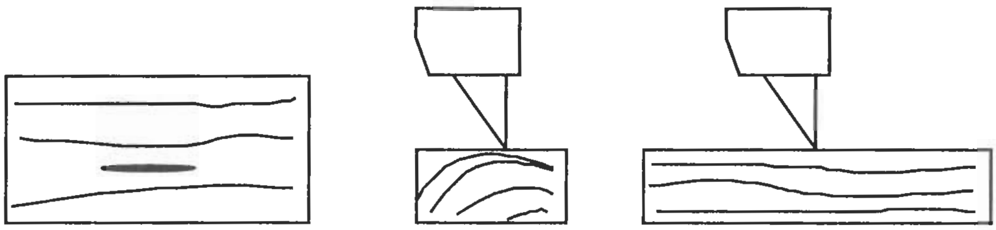
4.4.1 General group. Mat surfaces.

There is a bulk of different materials that falls into the general group, i.e. easily measured on for the OPTOCATOR. Generally these materials have a mat type of surface.

Examples from this group are paper, hot rolled steel, concrete, gypsum etc.

4.4.2 Fibrous material

The obvious example in this group is any kind of wood : logs, sawn boards, parquet blocks, etc. When the laser light meets this type of surface it is spread somewhat along the fibers. The center of gravity of the spot can then move out of the expected position and the result will be an error in the output data. This will occur if the optical triangle is oriented parallel to the direction of the fibers.



Top view
"The light spot
is spread along
the fibres"

Side view
along the board
"Optical triangle
perpendicular to the fibres"

Side view
across the board
"Optical triangle
parallell to the fibres"

Figure 16: Fibrous material

4.4.2.1 Advise

Mount the sensor with the optical triangle perpendicular to the direction of the fibers.

4.4.3 Shiny materials. Black and shiny materials.

Stainless steel, molten metal and other mirror like surfaces. They scatter very little light back to the detector due to the fact that most of the light is reflected according to optical law of reflections. The amount of light scattered in the direction of the receiving lens can vary rapidly over time and with a wide range of magnitude.

Black materials scatter only a small part of the incident light. Black materials in combination with a shiny appearance, like fresh extruded rubber or wet asphalt, requires a very powerful light control.

It is important to use an OPTOCATOR specially designed for measurement on this type of surface.

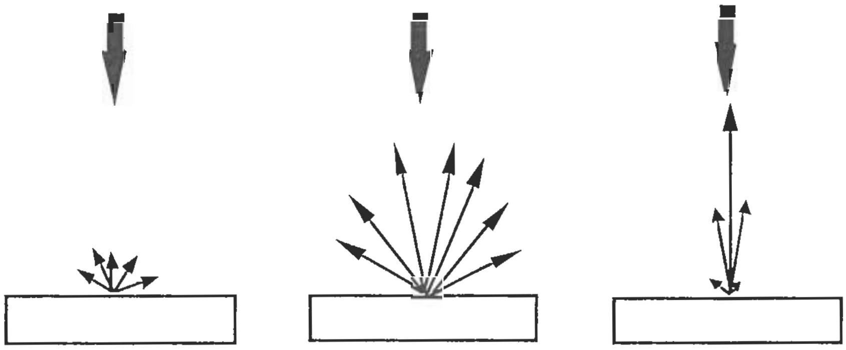


Figure 17: Illustration of reflection

4.4.3.1 Advise

For **extremely** shiny materials like molten metal (magnesium with protection gas or coated zinc plates very close to the bath) without any skin or oxide on the surface it may be necessary to tilt the OPTOCATOR somewhat to get enough light in the direction of the receiving optics. **Consult Selcom.**

Note that some material ages optically, e.g. car paint or uncured rubber. Compare an absolutely fresh sample from the extruder measured immediately and after 15 minutes a great difference will be noticeable.

4.4.4 Transparent materials

Transparent materials can not be measured since no light is scattered on the surface (e.g. glass). Transparent materials like **coolant oil or water** on a surface will add roughly half the thickness of the oil or water layer (given by the refraction index) to the thickness or position data.

4.4.4.1 Advise

The compensation for the layer thickness is roughly 50% of the actual transparent layer thickness. (For oil and water layers).

4.4.5 Semitransparent materials

The semitransparent material will scatter enough light to produce a stable measurement, but there will also be a penetration of light into the material and a contribution from internal reflections (as well as background reflections). The result is a position reading that is below the actual surface. The "offset" value depends on the degree of transparency. In many situations the offset is small and constant and can be calibrated for.

A method to measure this offset is to stick a thin strip of adhesive paper to the surface and scan the material (the thickness of a paper is approximately 0.1 mm).

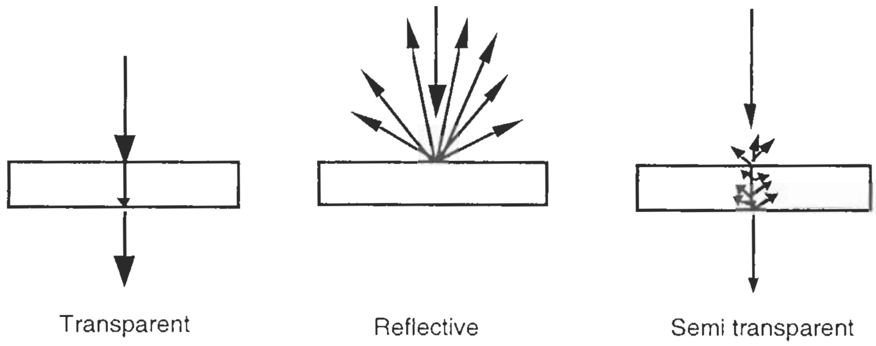


Figure 18: Light behavior on transmission material

4.4.6 Unstable thickness reading (beating)

In the case of a dual sensor system, the sensors will receive not only reflected light but also the transmitted light from "the opposite" OPTOCATOR. Since they are working at nearly the same frequency, they will interfere with each other. The output from the system will contain a low frequency component (~1 Hz) even if the set up is in steady state. This is an important phenomenon that has to be considered in all dual applications. Note that special designed OPTOCATOR ´s can be ordered to avoid this phenomenon.

4.4.6.1 Advise

Single sensor thickness measurement using a mechanical reference :

Offset compensation for penetration can be useful if the material is homogeneous.

Dual sensor thickness measurement on semitransparent materials :

Use Optocators designed for semitransparent materials.

4.4.7 Surface texture. Static texture error.

A basic statement to take care of is that the light spot produced on the target covers a certain area and the OPTOCATOR will respond to the *center of gravity* of the image of that spot on the detector. If the spot covers an area which gives an irregular amount of scattered light in the direction of the receiving optics, the OPTOCATOR reads a position of the surface below or above the true surface.

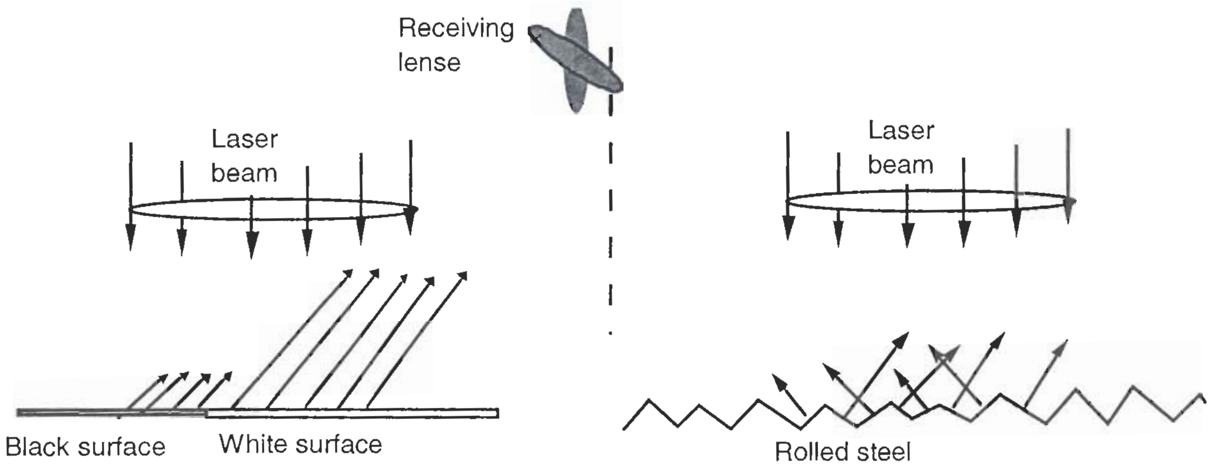


Figure 19: Reflection depending on target material

The change in the position output depends on the orientation of the sensor. The magnitude and the duration in length depends on the size of the laser spot. As a general rule the spot must be as small as possible. An example of output from the OPTOCATOR is shown in the figure below.

Note that if the OPTOCATOR is rotated 90 degrees to the orientation indicated, **no error spikes occurs.**

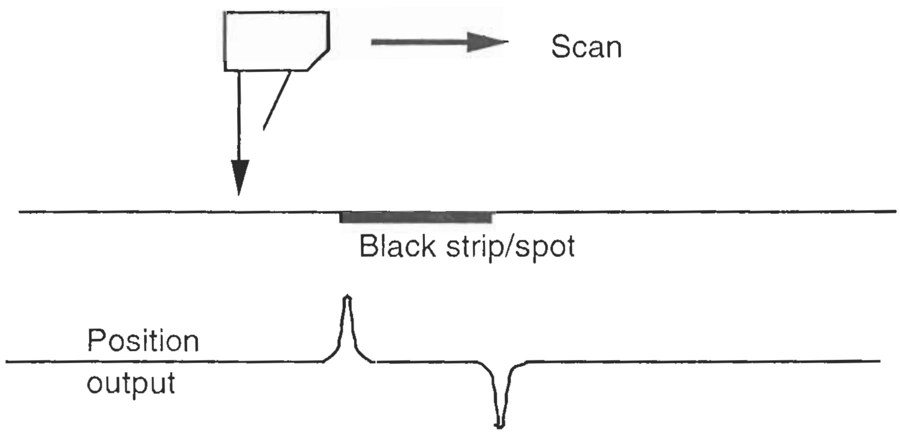


Figure 20: Example of output from the OPTOCATOR

Surfaces with a regular pattern from machining (e.g. rolling marks or from grinding) will cause an uniform scattered reflection. This will result as a static error that varies depending on where on the machining marks the center of gravity of the light spot is located. This error can be eliminated by scanning across the marks and averaging the measured data.

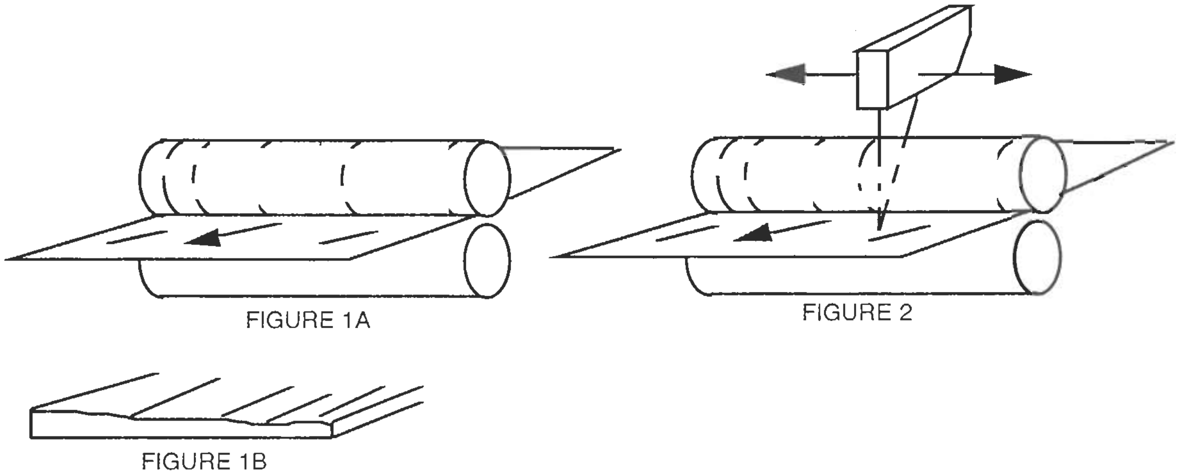


Figure 21:

Fig. 1 A	The regular surface is often produced in a rolling mill and looks like a rib mark structure along the strip.
Fig. 1 B	In other words regular thickness variations across the strip.
Fig. 2	The OPTOCATOR should be mounted parallel to the "ribs" and with a scanning direction across the direction of travel.

4.4.7.1 Advise

If possible orient the optical triangle parallel to surface irregularities.

If possible try to calibrate by letting the laser spot scan over a distance

(e.g. 10 mm) of the surface, to eliminate static texture error.

Calculate an average over distance when measuring.

4.4.8 Temperature of the material

Due to the given specification of the OPTOCATOR it has a maximum temperature coefficient of 100 ppm. That is for the OPTOCATOR housing temperature. The temperature of the object does not affect the accuracy at all.

4.4.8.1 Advise

The OPTOCATOR system will measure the actual thickness of the hot material . Be sure to take into account the temperature expansion effect when comparing with other measurements.

4.4.9 Geometry of the material. Secondary reflections.

The OPTOCATOR position data is given by the center of gravity of laser light on the detector. The laser light must origin from the laser spot on the surface. If laser light scattered from the spot reaches the detector via an secondary reflection that may affect the reading.

In most cases the phenomena can be avoided by orienting the OPTOCATOR according to the figure below.

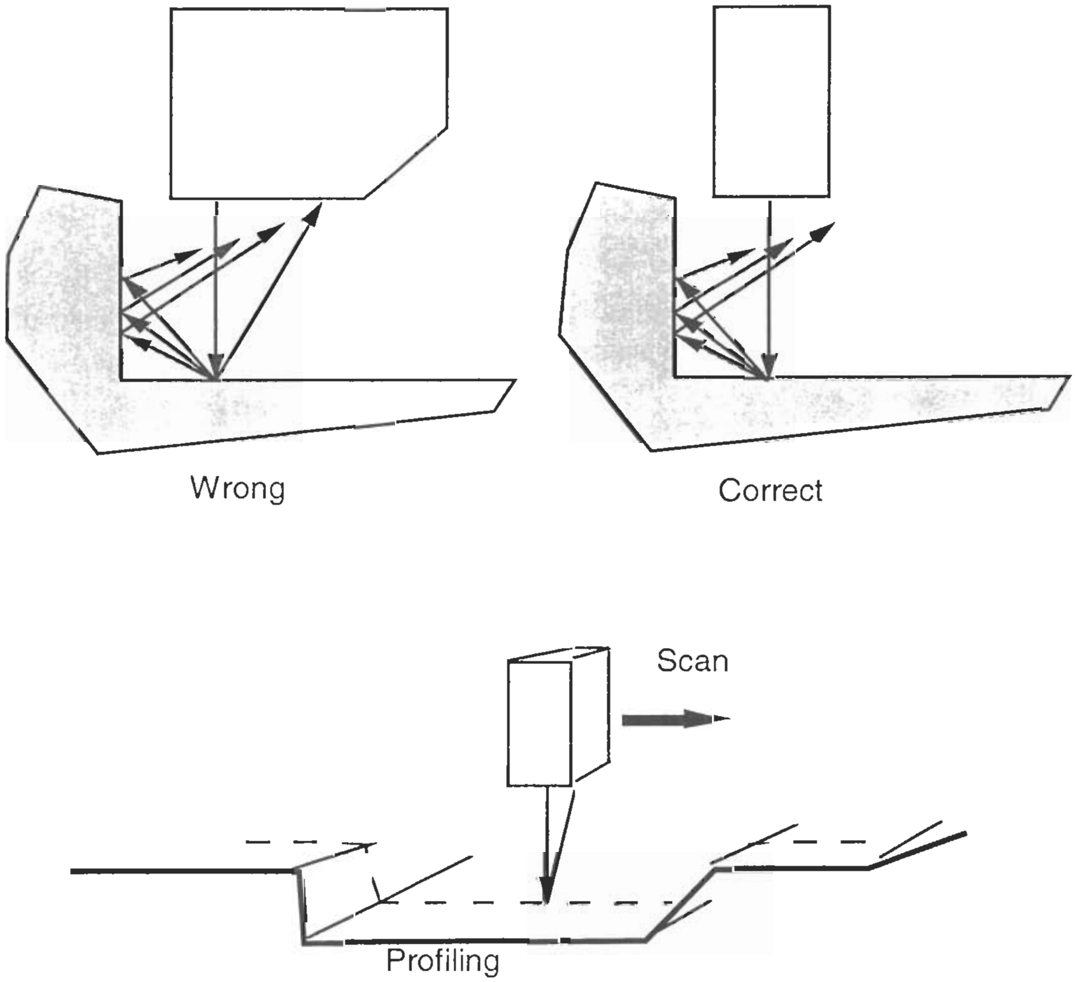


Figure 22: Sensor orienteering

5 TO ANALYSE A MEASUREMENT SITUATION

In this part of the manual the need of the signal processing and the necessity to analyze the measurement situation will be examined. To design and specify a modern process monitoring system or an on-line testing system the following items must be considered:

1. Measured quantity or quantities.
2. Dynamic range of measured value.
3. Bandwidth and sampling rate.
4. Data processing.
5. Total error.
6. "True value".

5.1 Measured quantity

The output from the OPTOCATOR system is, in principle, a distance, level or a thickness value. Figure 20 shows a typical result of a thickness measurement.

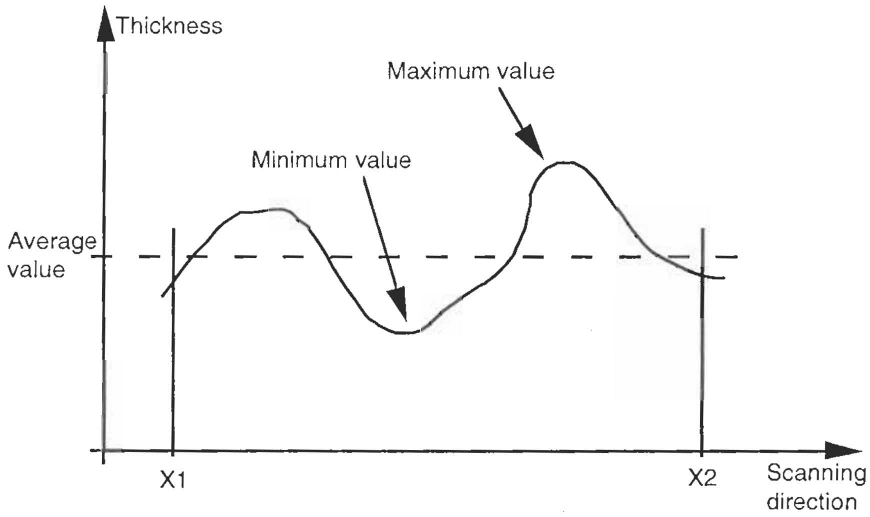


Figure 23: Cross section of a measured piece

The measured piece can be characterized by one or a combination of the quantities below :

- Average value.
- Maximum value.
- Minimum value.
- Fluctuation (Max. value - Min. value), expressed in extremes of RMS values (Root Mean Squares).
- Average value of a number of extremes.

5.2 Dynamic range of measured value

It is important to calculate the required minimum dynamic range for the sensor to optimize the performance of the system. The following points must be considered:

- The object's dimensional range, i.e. minimum and maximum thickness including tolerances.
- Mechanical vibration and movement of the object to be measured, caused by for example by change of rollers, rolling direction, mechanical forces, coil diameters and oil wipers.
- In dual probe systems, consider the possibility to have different range for upper and lower probes.
- Tolerances of the mechanical fixture for the probes.
- In some cases it may be favorable to have two different positions for the probe(s) if the range of production is wide.

5.3 Bandwidth and sampling rate

It is important to consider the bandwidth and sampling rate for the measurement system, in order to minimize the effect of noise, vibrations and aliasing errors.

The bandwidth describes the frequency response for the measurement system. Bandwidth can be converted to maximum output rate of change, time constant, settling time or step response. The bandwidth is given by physical laws for the object to be measured, by electrical filters in the probe and in the data processing part (SSP or OIM-board) and/or external computer.

Below you will find a typical measurement situation where it is important to choose a correct bandwidth of the system.

Object:	A forged axle
Diameter:	50 mm
Rotation speed when inspecting:	600 rpm
Detection level:	1: Surface defects longer than 5 mm in the rotation direction 2: Out of roundness

Surface speed is 600 / 60 x π x D = 600 / 60 x 3,14 x 50 mm/s = 1,57 m/s.

The out of roundness will give a fundamental frequency of 10 Hz but the detection of the surface defects requires higher frequency response.

The time constant T for a single pole filter with cut off frequency "f_o" is given by

$$T = \frac{1}{2 \times \pi \times f_o} \text{ seconds}$$

The measurement example as well as output from the filter is depicted in figure 21.

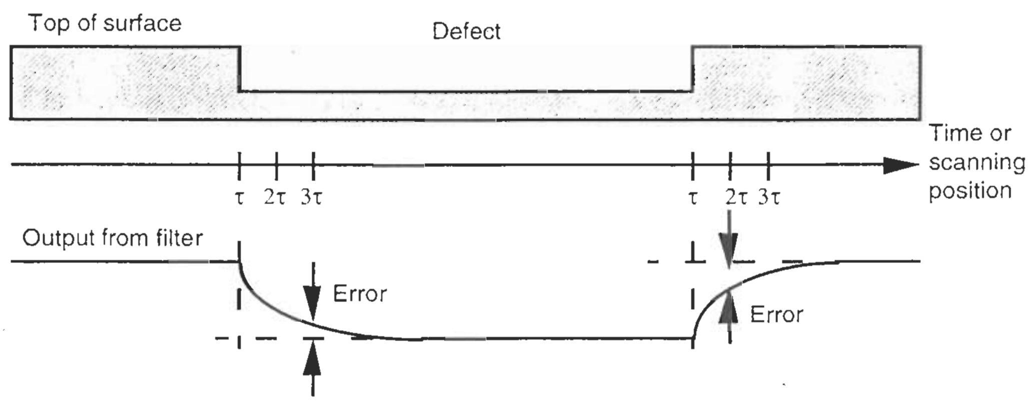


Figure 24: Output from the filter

Following error can be expected after given time.

Time:	Error (% of step):
T	36%
2T	13%
3T	5%
4T	2%
5T	0,6%
6T	0,25%
7T	0,09%
8T	0,03%
9T	0,01%

Acceptable error is used to calculate the bandwidth (cut off frequency).

Assume error < 1% of the step after 3 mm :

$$5T = \frac{3\ \text{mm}}{1{,}57\ \text{m/s}} = 1{,}9\ \text{ms}$$

$$T = \frac{1{,}9}{5}\ \text{m/s} = 0{,}38\ \text{ms} \quad => \quad f_o = 420\ \text{Hz}$$

A cut off frequency of 420 Hz will give an error less than 1% of the step after 3 mm along the scanning direction.

The noise error will perhaps set another limit of the bandwidth (see section 5.4 and 5.5). The selection of the proper bandwidth may involve trade-offs between this settling time error and the noise error.

The word sampling is equivalent to take, read, pick, input data. When you have selected the proper bandwidth you must select a sampling rate high enough to avoid aliasing errors.

In broad band sampled-data systems you cannot avoid aliasing errors without input filtering, which must take place between the signal source and the sampler input (routine in the software of the computer). Once an unfiltered signal passes through the sampler, the aliasing error becomes so imbedded into the signal that there is no method known that is capable of separating the signal from the error at the output.

Aliasing errors occur when you sample a time-varying signal and if the input changes significantly between samples. An extreme case illustrates the characteristic of leasing errors, see figure 25. A sine wave at the sampling frequency rides on the dc input (vibrations riding on a static position). The sampled output - the apparent value of the input signal - is a constant value in the input's peak to peak range. The value depends on the relative phase of signal and sample frequencies.

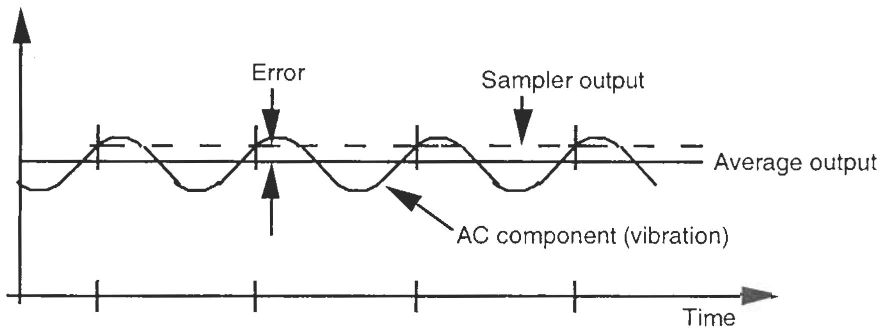


Figure 25: Aliasing error

Aliasing error is a constant when the period of the AC component of the sampled signal and the sampling interval is equal.

To avoid these errors you must lower the amplitude of input signal spectral components with frequencies above 0,5 of Fs (sampling frequency) by adequate low-pass signal filtering before the sampler. SELCOM recommend that the sampling frequency is at least 10 times the cut off frequency.

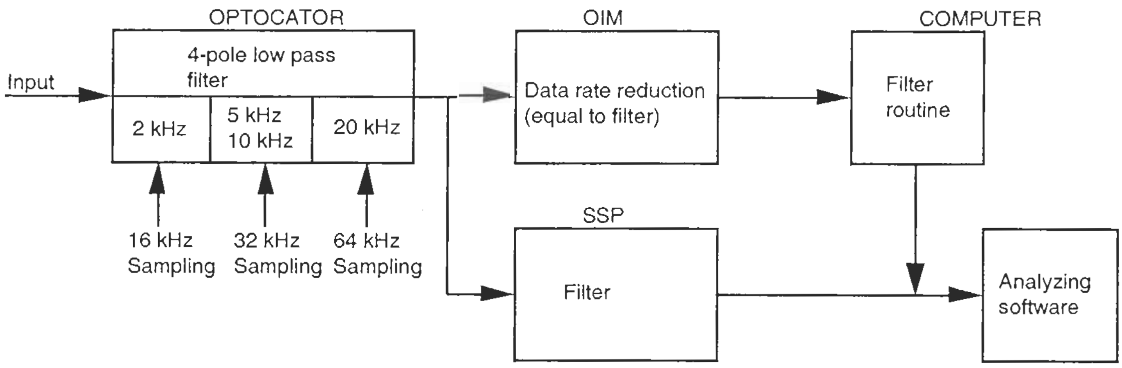


Figure 26: Bandwidth reduction

5.4 Data processing (for external computer)

After selecting the proper bandwidth and sampling frequency and the wanted measured quantity (i.e.) the data handling procedure can be designed. Take advantage of cyclic data to reduce errors, see fig. 27. By proper processing, the quality of cyclic data may be improved.

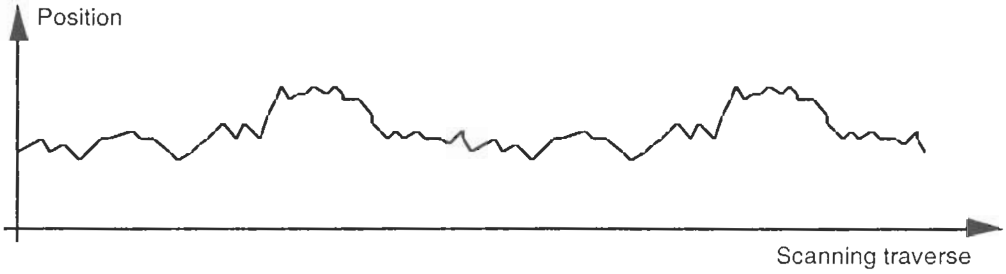


Figure 27: Cyclic output

The thickness variations in figure 27 can for example be caused by an out-of-round roller. By coupling the data with the roller position, its effect on the thickness measurement can be eliminated.

It is a good approach to reduce the data speed from the OPTOCATOR before sending it to a computer. This can be done by using different filters in the SSP or by averaging on an OIM board. Select the update time to be equal to the sampling time in the computer (see section 5.3). The data can then be put into a software filter routine in the computer (not necessary when using an SSP since a choice of filter routines are available that produces data that can immediately be handled by user written analyzing programs), updating the routine every time new data is coming, see figure 28.

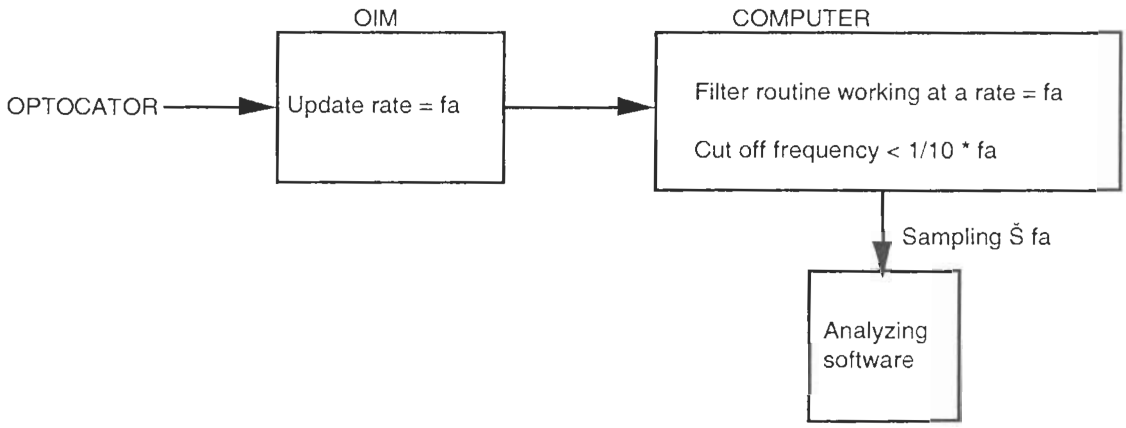


Figure 28: Processing

If the analog output is used you must add adequate filtering (in the microprocessor or before your ADC input).

Use a proper calibration routine to reduce error sources. The calibration procedure should contain a testing sequence, i.e. a checking point proving that the system is working properly.

5.5 Total error

The total error is the sum of all error sources. Total error is given by the Root Mean Squares of the error sources:

- Non linearity.
- Non accuracy.
- Temp. drift in the probe(s).
- Temp. drift of the mounting mechanics for the probe(s).
- Settling time.
- Noise.
- Systematic error caused by calibration piece (causes off-set) and calibration procedure.

By proper calibration procedures these errors can be decreased significantly.

Noise has a near Gaussian amplitude distribution, the highest noise amplitude having the lowest probability. The noise can be expressed as RMS quantities; multiplying a Gaussian RMS quantity by six results in a peak to peak value that will not be exceeded 99,73% of the time. If the bandwidth is changed the noise level is given by:

$$\frac{\text{Noise(BW1)}}{\text{Noise(2kHz)}} = \sqrt{\frac{\text{BW1}}{\text{2kHz}}}$$

BW = Bandwidth

Bandwidth:	*Relative noise figure:*
2 kHz	1
500 Hz	0,5
100 Hz	0,22
50 Hz	0,16
10 Hz	0,07
1 Hz	0,022
0,1 Hz	0,007

The calibration piece must have a well known thickness and if possible a value close to the actual object to be measured. The surface condition should be matte (etched), to avoid surface static errors caused by scratches.

5.6 "True value"

The "true value" is the measured value that the OPTOCATOR value is compared with in order to see if the OPTOCATOR output is true. The "true value" is normally established with a manual measurement using a manual tool such as a caliper, snap gauge etc.

It is important to be aware of the components affecting the manual measurement of the "true value" :

- Method of manual measurement
- Error of manual gauge
- Shrinking of measured object between OPTOCATOR and manual measurement (for example rubber, hot metal, wood, etc.)
- Contacting method may affect the measured object (depression of the top layer)
- Manual method may only give peak values due to peaks in the surface and the gauge used
- Different measurement positions may give different results

6 SERVICE AND MAINTENANCE

6.1 General

NOTE: **It is possible during installation that unintentional exposure to laser light may occur take extra care not to look into the laser aperture of the OPTOCATOR unless you are certain that the laser beam is turned off. Tools that are used during installation may give mirror like reflections. If possible wear protective goggles.**

The laser beam of the OPTOCATOR can not burn skin.

The apparatus is guaranteed for one year against manufacturing defects on the following conditions:

- The specified temperature limits must not be exceeded.
- The sensor optics must not be subjected to any other treatment than careful cleaning, see section 6.2 below.
- The protective cover for the electronics on the sensor must not be opened.
- External units may not be connected to the OPTOCATOR in any other way than the one which has been recommended by Selcom.
- The laser should be turned off whenever measurements are not being made.
- Only personnel approved by Selcom may perform service on the equipment.

Warranty repairs will be performed at Selcom during normal working hours. The costs of freight to Selcom must be paid by the user. The cost of freight for warranty repaired equipment back to the customer will be paid by Selcom.

Selcom will provide transport insurance for the goods when the transport is paid by Selcom. The user is advised to insure the goods for the transport to Selcom.

6.2 Cleaning of optics

In any and all installations, the front optics of the OPTOCATOR will be subjected to dirt of some kind.

Cleaning of the optics/protection glass must only be made with spirits (cleaning alcohol) on a soft clean rag or tops (do not use paper of any kind, it contains small grinding particles that will scratch the glass).

Dirt that can influence the measurement includes :

- Light, dry dust.
- Grease or oil spray.
- Larger particles that can scratch or damage the protection glass.
- Finger prints on the optics or the protection glass.
- Fog.
- Sparks that burns and sticks to the protection glass.

Note: If the OPTOCATOR is equipped with an air purge system, filters that eliminates dust, water and oil from the air must be used.

6.3 Troubleshooting

This section will help you to pinpoint the faulty part and in some cases correct the problem of an OPTOCATOR system

Please observe that SELCOM or your local distributor is always ready to assist you whenever you need additional technical information.

If a faulty part has been identified, please fill in a SERVICE REPORT (found at the back of this manual) as detailed as possible and send it together with your faulty equipment to your SELCOM representative for repair.

Symptom:	*Check:*
1. The Laser warning LED does not turn on	A. Check that the power is on.
	B. Check the Remote Control on the SSP or the OIM
	C. Check the cables between the OPTOCATOR and the SSP/OIM.
2. Invalid light is on (SSP or OIM)	A. Check that the measured object is within the Measurement Range.
	B. Check that the lenses are clean and that the emission shield is open.
	C. Check that the measured object gives enough scattered light back. This is easily done by placing a good reflective material (e.g. paper) on the object. If the invalid lamp goes out, the surface of the measured object may not scatter enough light. Consult SELCOM or your local distributor for advice
	D. Check the cable connection between sensor and SSP/OIM.
	E. Check with an IR-viewer or IR-plate if you can observe a spot on the measured object.
	F. Try to determine with an IR-viewer or IR-plate if the light regulation is working properly. This is done by placing an object in the measurement range and moving it either out of the far end or the close end of the measurement range. If the intensity of the spot remains constant (bright) both inside and outside the measurement range consult Selcom for advice.

Symptom:	*Check:*
3. The "POWER" lamp is not on	A. Check main fuse on the SSP or the OIM.
4. The SSP display shows a completely wrong value	A. Make sure that the object is within the measurement range B. Check parameter settings.
5. The OPTOCATOR is non-linear	A. Make sure that you have connected the OPTOCATOR with the right PPU. Check the serial numbers, THEY MUST MATCH B. Check that both lenses are clean. C. If still non-linear behavior consult SELCOM or your local distributor.

7 ACCESSORIES

7.1 Dust and heat protection

- Air purge kit for OPTOCATOR type 2008.
- Air purge adapter for OPTOCATOR type 2201.
- Air purge adapter for OPTOCATOR type 2207.
- Water cooled jacket for OPTOCATOR type 2008.
- Adapter kit for water cooled jacket (2008).

  Needed when replacing a 2005 with a 2008 type of OPTOCATOR in an existing water cooled jacket.
- Water cooled jacket for OPTOCATOR type 2207.
- Heat protected cables.
- Blowers.
- Air cooling unit (includes blower, filter and air cooler).
- Air cooling/heating unit (includes blower, filter, air cooler and air heater).

7.1.1 Cables

- Extension cables (variety in length and connectors available, contact SELCOM for information).
- Junction box type 20008 (for use with 2 OPTOCATORs, see section 4.1).

7.1.2 Light spot detection

Mounted on the sensor, mixing red LED light with the laser light :

- Visible Light Adapter (VLA) for 2201.
- Visible Light Adapter (VLA) for 2207.

Adjustment aid :

- IR viewer.
- IR plate.

7.1.3 Welding spatter protection

- Pneumatic shutter 2204.
- Pneumatic shutter 2301.

7.1.4 Interface units

- OPTOCATOR Interface Module (OIM-I).
- OPTOCATOR Interface Module with laser safety panel (OIM-II).
- OPTOCATOR Interface Module (OIM-I)
- with direct analog output DAO.
- OPTOCATOR Interface Module with laser safety panel (OIM-II) with direct analog output DAO.
- Selcom Signal Processor (SSP).

Contact SELCOM for further information.

8 OPTICAL TRIANGULATION

8.1 This is optical triangulation

The OPTOCATOR consists of a light source and a detector integrated with optics and electronics. The light source is an infrared, near infrared or visible semi conductor laser diode. The laser diode illuminates a spot on the surface of the object to be measured, (log, car body, gypsum board etc.).

"An electronic eye, that detects an invisible light spot"

The spot is invisible to the human eye when the OPTOCATOR utilizes an infrared or near infrared laser. It is though visible to the detector of the OPTOCATOR. The detector is situated at the back of the receiver part, similar to the retina of the human eye. An image of the spot is focused on the detector.

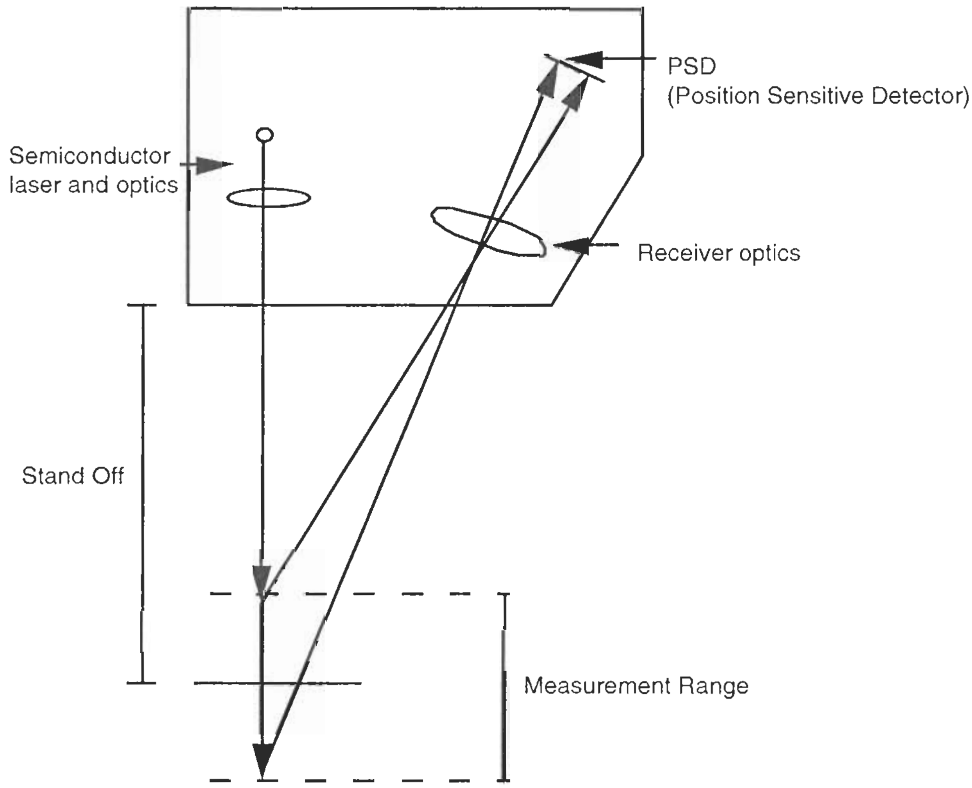


Figure 29: The optical triangulation principle

Depending of the distance between the OPTOCATOR and the light spot, the image of the light spot will be focused on a certain spot on the detector. The detector is a high resolution, position sensitive detector. It converts the spots light to electrical signals, which the electronics use to determine the actual distance to the object.

"Moving objects, no problem"

The measurement is very rapid. The OPTOCATOR repeats the measurement sequence up to 64000 times per second. This makes it possible to measure moving and vibrating objects.

By using several OPTOCATORs you can measure thickness, profiles, diameters etc. The accuracy is high, the error is normally less than 0.1% of the measurement range. (See section 4.2 "Mechanical installation) The OPTOCATOR is also insensitive to ambient light.

8.1.1 The analog position sensitive detector

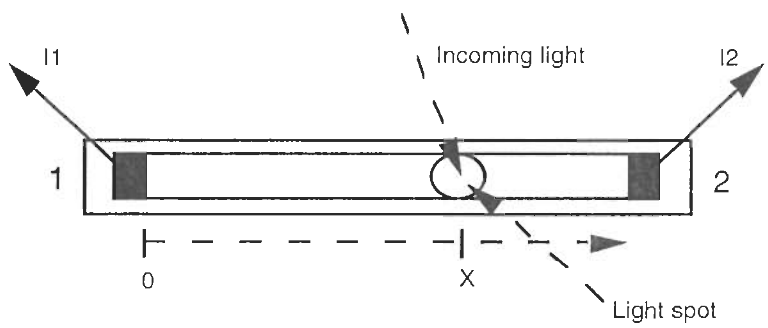


Figure 30:The analog position sensitive detector

As light hits the detector, two currents I1 and I2 are generated.

The ratio between the currents is given by the distances between the spot and the electrodes 1 and 2. These currents are used by the electronics to determine where on the detector the spot is, thereby knowing where the measured surface is.

8.1.2 Advantages

Fast. Allows sampling rates of up to 64000 times per second.

High suppression of ambient light.

Very high resolution. Limited only by the sensors´s Analog-to-Digital converter.

This technique also allows for fast regulation of the output laser power. This fast regulation makes measurement of almost any material or surface possible and allows for fast and big variations of measured surfaces color and reflectiveness.

8.1.3 Linearization

The function between the raw output from the detector and the actual distance between the OPTOCATOR and the measured object is non-linear by nature. This non linearity is mainly due to the geometry in this type of measurements and to the analog portion of the data processing. Therefore, each sensor is factory calibrated to compensate for any non-linearity or other built-in error.

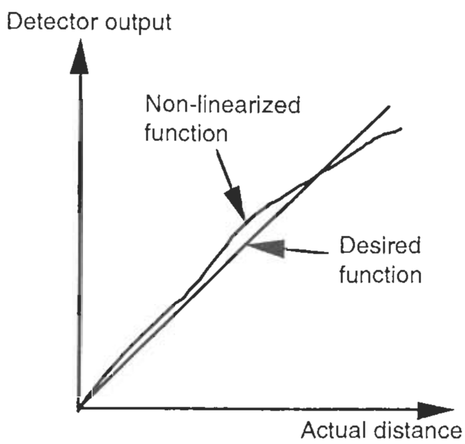


Figure 31: Illustration of linearization

Linearization is performed for each sensor by establishing of a correction table which is calculated and stored in the sensor.

9 TECHNICAL SPECIFICATION

Principal diagram :

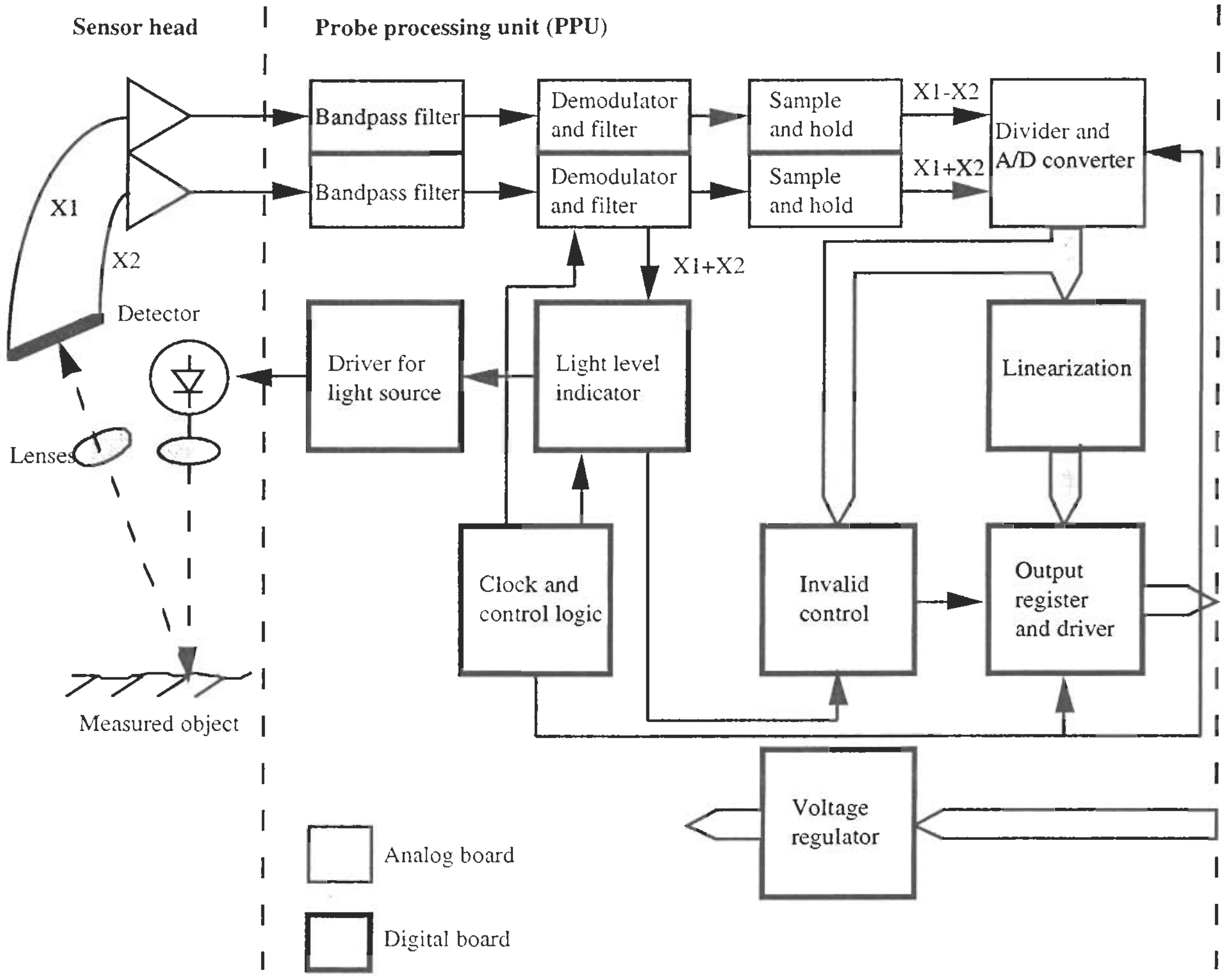


Figure 32: Block diagram

Dimensions :

According to the dimensional drawing.

Environmental conditions :

Temperature :

Operating :	0 to 40°C	(32-104 °F)
Storage :	-30 to 70 °C	(-20-160 °F)

Relative humidity 10-90 %, non-condensing.

Protection class :	IP40	NEMA 2
(2201 and 2207	IP65	NEMA 4)

(excluding connector).

Power requirements :	
Input voltage :	
	+20 V (±1V) max. 100 mA
	- 20 V (±1V) max. 100 mA
	+15 V (±4V) max. 160 mA
	+18 V (±3V) max. 150 mA
Inaccuracy :	+/-0,1 % of Measurement Range at BW 50 Hz (includes non-linearity and error)
Scale factor:	1/4000 of MR. 1 LSB is equal to the scale factor.
Resolution :	0,025 % of MR, digital resolution of serial output. 0,0015 % of MR by signal processing.
Repeatability:	± 0,2% of MR at BW 2 kHz (standard) ± 0,006 % of MR at BW 5 Hz
Precision:	± 0,01% of MR at BW 5 Hz.
Non linearity:	± 0,025% of MR with a mat white paper target.
Temperature stability:	Scale factor change: typical <0,005 % of MR per degree C. max. 0,01 % of MR per degree C
Response time: (Position data, within 10% of final value)	160 micros. for BW 2 kHz 65 micros. " 5 kHz 32 micros. " 10 kHz 16 micros. " 20 kHz
Surface Reflectivity Compensation:	Included, fully automatic. Dynamic range $5x10^6$. Compensation speed down to 8 microseconds,100%.

Output signal interface :

16 bit serial synchronous interface, including 12 bit measurement data and 3 bit valid/invalid signal.

Updating frequency	16, 32 or 64	kHz
Bandwidth		
at 16 kHz	2	kHz
at 32 kHz	5 or 10	kHz
at 64 kHz	20	kHz

Balanced data output : D + D -inv., C + C-inv.

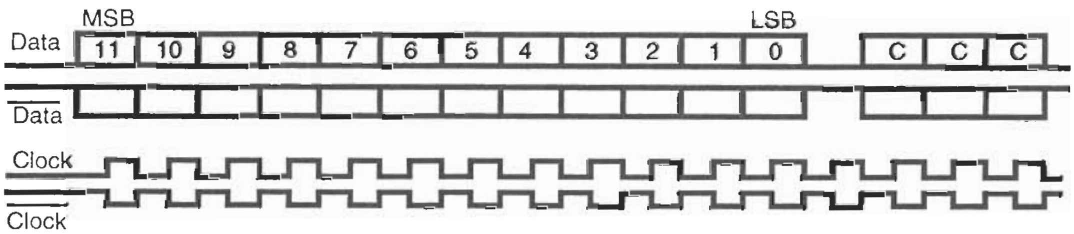


Figure 33: Data output format

Logical "1":	C > 0.6 V + C-inv.
	D > 0.6 V + D-inv.
Logical "0":	C-inv. > 0.6 V + C
	D-inv. > 0.6 V + D

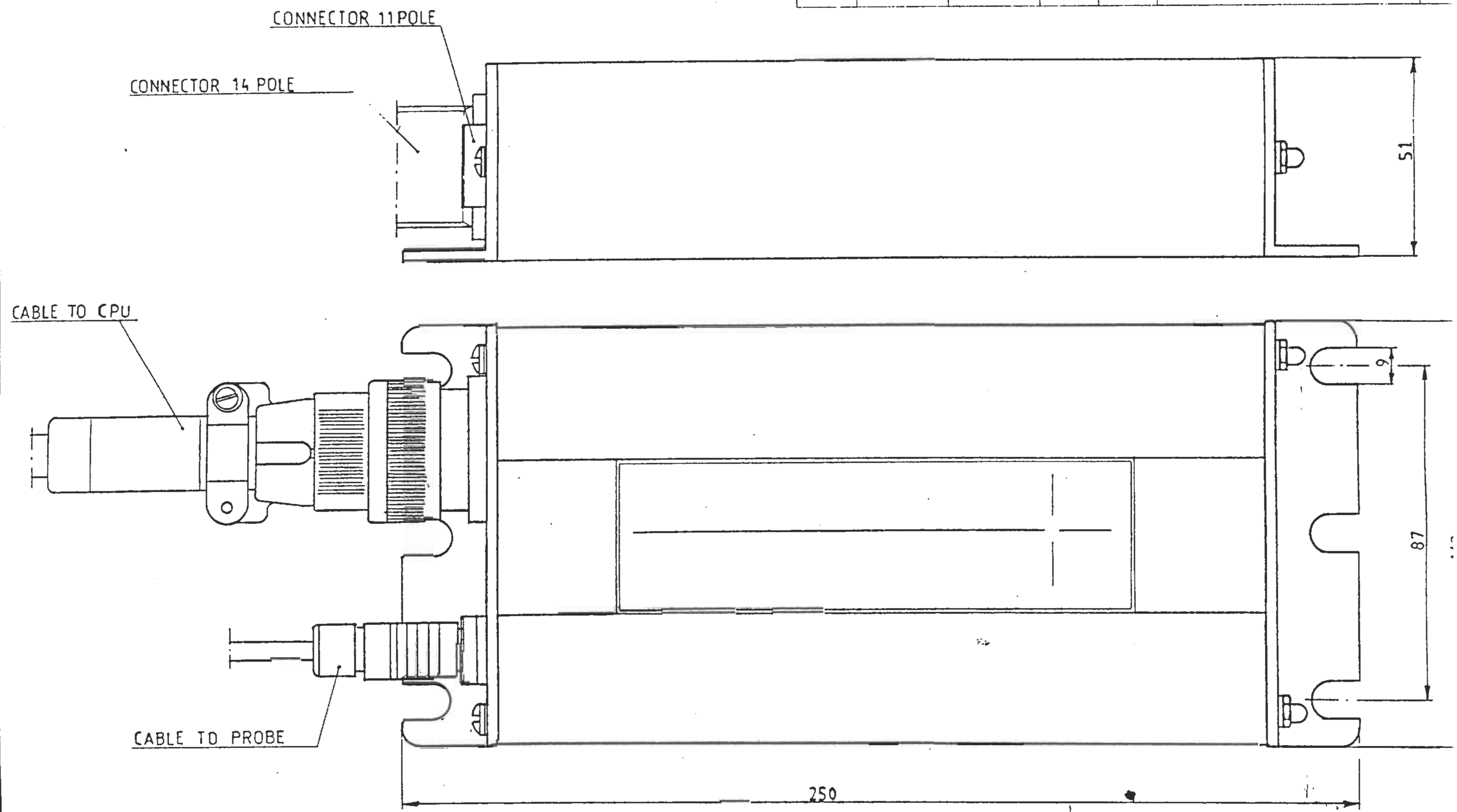
Max. Load : (OH = Output High, OL = Output Low)

Voltage:	U(OH) > 2.0 V
	U(OL) < 0.8 V
Current:	I(OH) > 40 mA
	I(OL) < -40 mA

APPENDIX A, Revision page

Rev.:	*Date:*	*Page:*	*Description:*
P1	940901		Initial version
P2	941122		Change request (PI-4019)
P3	950505		Service Report changed (PI-4026)
P4	961021	All	Appendix G added. (PI4040) New page numbering
P4.1	961112	13-14	Sec.4.1. figure 19 and Power supply information is corrected. (ÄB6-101)
P4.2	970821		Table of contents, new addresses, 'Printed in Sweden'
P5	981113	All	The layout is changed

APPENDIX B, Dimensional drawing PPU

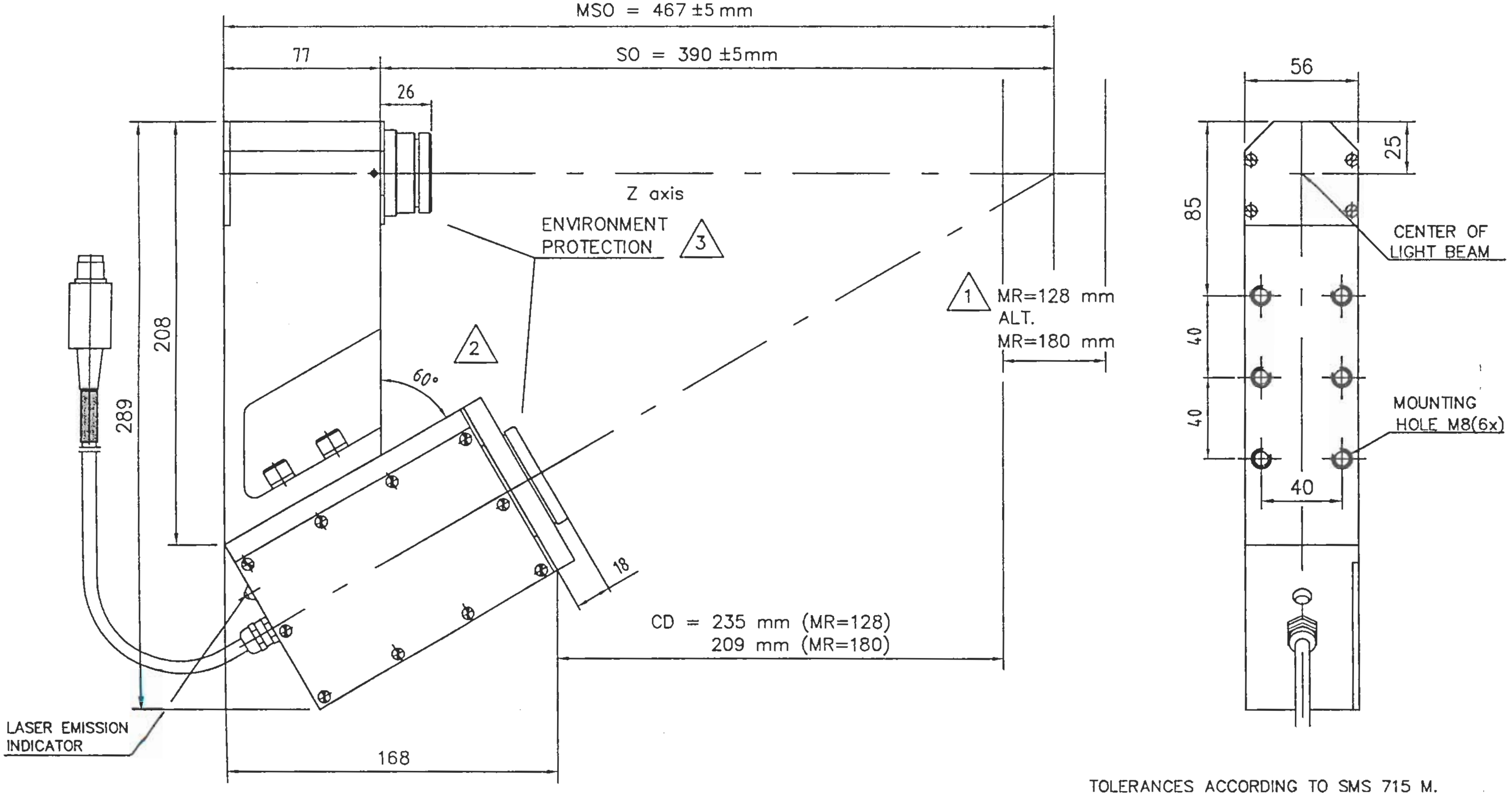


WEIGHT = 0,9 KG

COPY LIST	PROD	MTRL	PLAN	QUAL	MATERIAL		
NUMBER					DOC SPEC	STAGE D	STAGE P
NAME AL			DATE 870422		SCALE 1:1 SHEET	DATE 870428 APPR	DATE
Selcom SELECTIVE ELECTRONIC CO AB			DIMENSIONAL DRAW. PPU			NO 803836	STAGE D1

APPENDIX C, Dimensional drawing sensor head

STAGE	DESIGN CHANGE NO	DATE	NUMBER	PLACE	DESIGN CHANGE	SIGN
P2	1	95-05-08			MR=180 ADDED	MR
P3	6-055	96-08-21	2		CHANGE ANGLE	AL
P4		00-08-09	3		ENV.PROT. ADDED	KS



TOLERANCES ACCORDING TO SMS 715 M.

Z AXIS=LIGHT BEAM AXIS
MSO=MOUNTING STAND OFF
SO =STAND OFF
CD =CLEARANCE DISTANCE
MR =MEASURING RANGE

WEIGHT =

Nr	Ant.	Ändring och/eller medd.-nr	Datum	Inf.	Godk.

ITEM NO	ART/DOC NO	DESCRIPTION	A-SIZE	UNIT	QTY	REMARK
COPY LIST	PROD / MTRL / PLAN	MATERIAL				
NUMBER			STAGE D		STAGE P	
NAME: KON SUPPORT	DATE: 94.03.27	SCALE	SHEET	DATE / APPR	DATE: 2000-08-17	APPR

LMI Selcom MEASUREMENT & CONTROL

PROBE WITH ENV. PROT.
2008-128 ALT180-390
DIMENSIONAL DWG

NO 808357

STAGE P4

APPENDIX D, Addendum

Service report

LMI Selcom
MEASUREMENT & CONTROL

Please fill in the header and a description of the problem and send the form to LMI SELCOM together with your equipment

Customer : ______________________ **Date :** ______________________

Reported by : ______________________ Telephone : ______________________

Address : ______________________ Telefax : ______________________

______________________ Attention : LMI SELCOM Service Dep.

Equipment **Type** **S/N** **Description of the problem or symptom:**

☐ Repair and return

☐ Send us an estimate of the cost of repair and wait for our confirmation

Filled in by LMI SELCOM Checked by :

Service check

Action Action performed by :

Sweden
LMI SELCOM AB
Box 250
S-433 25 PARTILLE, Sweden
Telephone : +46 31 336 25 00
Telefax : +46 31 44 61 79

USA
LMI SELCOM, INC
21666 Melrose
SOUTHFIELD MI 48075, USA
Telephone : +1 248 355 5900
Telefax : +1 248 355 3283

APPENDIX E, Addendum

Empty on purpose

APPENDIX F, Addendum

Empty on purpose

APPENDIX G, Quality Record

The Quality Record is delivered together with every sensor from Selcom. Its purpose is to present the most important data about the sensor in a compact way.

More information about different aspects of the Quality Record information, such as laser safety, specifications etc. is available in the relevant manual sections. This appendix is just intended as a quick reference.

Top Art

The top part of the Quality Record page is devoted to text information. It is subdivided into sections which group related parameters together. The following list explains what each parameter means.

Section "Sensor Info"

Sensor type:	The sensor's official type designation.
Part number:	Selcoms internal part number.
Serial number:	The serial number of this particular sensor.
Date:	The date when the Quality Record was printed.
Operator:	The name of the person who was responsible for preparing this sensor for delivery.
Signature:	The operator's personal signature.

Section "Parameters"

Measurement Range:	The ***nominal*** Measurement Range for the sensor type. The actual Measurement Range for each individual sensor may be different from the nominal value by as much as shown by the tolerance indication in parenthesis.
Mounting Stand_off:	The ***nominal*** Mounting Stand-Off for the sensor type. The actual Mounting Stand-Off for each individual sensor may be different from the nominal value by as much as shown by the tolerance indication in parenthesis.
Scale Factor:	The ***nominal*** Scale Factor for the sensor type. The actual Scale Factor for each individual sensor may be different from the nominal value by as much as shown by the tolerance indication in parenthesis.
Outputs:	The output interfaces available in this sensor. Optocators always have just one output (the "Selcom" output). SLS sensors have multiple outputs: RS-232, one out of two different analog

	outputs, and one out of either the "Selcom" or RS-422. See **Explanations** section below for information about these different interfaces.

Sampling Frequency:	The basic rate of raw data collection in this sensor (see **Explanations** section below).
Bandwidth:	The analog bandwidth of this sensor.
Special tests:	Some sensor types for specific applications must be put through special tests which are not compulsory for all sensors. The operator must check one of these two boxes to indicate whether such tests are required, and if so that they have been carried out.

Section "Laser Safety"

Max average power:	The laser in Selcom's sensors is a pulsed type, i.e. it emits pulses of very brief duration and is shut off in between. This number indicates the maximum power if the pulses are averaged over time.
Wavelength:	The laser emits light of a single wavelength, given in nanometers. There is an indication in parenthesis which tells whether light at this particular wavelength is visible (see **Explanations** section below).
Safety distance:	The laser light always has a certain divergence, which makes the energy density decrease as the distance from the laser increases. At a certain distance, the energy density falls below the level where a direct exposure can cause damage to the human eye. How this distance is defined and how it should be calculated is specified in international standards EN60825 and IEC825. The number here is calculated according to these standards.
Emission delay:	Selcom's sensors can be equipped with two different types of emission delay. One (called **Laser ON** delay) will always cause a short delay every time the laser control signal is turned on, before the laser actually starts emitting laser light. The other type (called **Power ON** delay) will only cause a delay when the sensor is first powered up. All subsequent cycling of the laser control signal will control the laser without any delays.

Explanations

The **"Selcom" output** is a proprietary synchronous serial output. It uses a clock and a data signal, with the clock only running while data is being transmitted. Each data item is 16 bits.

RS-232 and **RS-422** are standard asynchronous serial interfaces.

The **analog output** from the SLS sensors can be configured either for 4 - 20 mA or 0 - 20 mA operation.

Sampling frequency and **bandwidth** are related but not identical quantities. The sampling frequency tells how often the sensor evaluates the raw analog signal by performing an A/D conversion. The bandwidth value tells how that analog signal is conditioned before the A/D conversion. In order to avoid certain signal processing problems, the bandwidth has to be lower than the sampling frequency (it may not exceed 50% of the sampling frequency), and for that reason the signal is put through an analog filter stage before the A/D conversion. Although it is not a theoretically correct way to express it, one might say that the bandwidth determines how fast a measurement signal may change, and have the change detected by the sensor.

The **wavelength** of a laser is important for two reasons:

- You need to know if you want to purchase protective equipment (goggles).
- It determines if the light spot can be detected by human eyesight. This is an important safety factor, because invisible radiation obviously constitutes a danger to people who are not aware of its presence.

The lasers used by Selcom are classed as ***visible***, ***near-visible IR*** (infra-red) or ***invisible IR***. The near-visible IR class needs some further explanation. At these wavelengths, the laser light spot is visible under favorable circumstances, i.e. output near the laser's maximum, low ambient light, and a suitable surface, e.g. a piece of blue paper.

Bottom Part

The bottom part of the Quality Record shows a diagram which is generated during the linearization procedure. Every sensor goes through the linearization process, because the raw signal from the detector is non-linear due to optical geometry and reproduction errors. In the linearization process, a translation table is constructed and stored in non-volatile memory inside the sensor. When the sensor measures, the raw data values are used as addresses into the table, and the output consists of the data from those addresses.

The linearization is made by using a moving target, and simultaneously reading data from the sensor and a reference scale which gives the target's position with great accuracy. The target material is white paper, which is a "neutral" material in terms of light reflection and dispersal.

The diagram shows the result from a check (on the same white paper target) which is made after the translation table has been installed in the sensor. The ideal result is a perfectly flat graph on the zero line. In practice there are always a few small deviations, because of noise from the sensor. The important thing is that the general "trend" of the line is horizontal, i.e. that the scale factor is correct.

The linearization as well as the linearity check are both made with the "Selcom" interface.

The target's distance (in millimeters) from the sensor's mounting surface is shown in the diagram's horizontal axis. On the vertical axis you can see the deviation from linearity in sensor LSBs. The size of one LSB (least significant bit) in millimeters is given by the sensor's scale factor.

The scale factor that results from the check measurement is printed out explicitly in the upper part of the diagram. In the line above that one, you can see the Measurement Range that has been achieved, both in millimeters and as a percentage of the nominal Measurement Range.

The upper right corner of the diagram contains the date and time when the check was performed, the sensor type and serial number, and the name of the operator.

8.2 Appendix II

Test Data

8.2.1 Sand Patch Test Data, As Collectected in accordance with ASTM E 965, "Standard Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique."

Texture Study NBTL/26050/SR-24/FC-3										
Lockup Point	Site #	Volume Sand	1	2	3	4	Mean (in)	MTD (in)	Mean (in)	MTD (in)
	1	1.5	10.5	10.0	10.0	10.1	10.2	0.01855		
	2	1.5	10.6	11.0	10.7	10.9	10.8	0.01638		
	3	1.5	11.0	10.5	10.7	10.3	10.6	0.01693		
1	4	1.5	10.0	9.8	9.9	9.7	9.9	0.01969	10.4	0.01782
	1	1.5	9.3	9.1	9.1	9.0	9.1	0.02295		
	2	1.5	9.1	9.3	8.6	9.0	9.0	0.02359		
	3	1.5	9.2	9.1	9.1	8.9	9.1	0.02320		
2	4	1.5	9.4	8.7	9.1	8.9	9.0	0.02346	9.1	0.02330
	1	1.5	9.7	9.6	9.6	9.2	9.5	0.02106		
	2	1.5	10.2	9.3	10.1	10.0	9.9	0.01950		
	3	1.5	9.7	10.0	10.2	9.8	9.9	0.01940		
3	4	1.5	9.8	9.0	9.9	9.7	9.6	0.02073	9.7	0.02015
	1	1.5	9.7	9.4	9.8	9.2	9.5	0.02106		
	2	1.5	9.0	9.0	9.1	9.1	9.1	0.02333		
	3	1.5	9.0	9.3	9.3	8.9	9.1	0.02295		
4	4	1.5	9.4	9.3	9.9	8.9	9.4	0.02174	9.3	0.02224
	1	1.5	9.2	9.2	9.3	9.0	9.2	0.02270		
	2	1.5	9.5	9.4	9.1	9.6	9.4	0.02163		
	3	1.5	9.5	9.4	9.6	9.6	9.5	0.02106		
5	4	1.5	9.6	9.5	9.5	9.7	9.6	0.02084	9.4	0.02154
						Mean			9.6	0.02101

Figure A-II-1 Summary of Volumetric Macro-Texture Data Collected on 02/17/04, on Test Section #1 (FC-3) in Accordance with ASTM E 965.

Texture Study NBTL/26050/SR-24/FC-2										
Lockup Point	Site #	Volume Sand (in^3)	1	2	3	4	Mean	MTD (in)	Mean	MTD (in)
	1	1.5	5.5	5.2	5.0	5.7	5.4	0.06676		
	2	1.5	5.5	5.4	5.0	5.2	5.3	0.06867		
	3	1.5	5.6	5.7	5.3	5.4	5.5	0.06317		
1	4	1.5	5.5	5.5	5.5	5.2	5.4	0.06493	5.4	0.06583
	1	3.0	8.4	8.0	8.0	8.5	8.2	0.05649		
	2	3.0	8.1	7.8	8.0	8.4	8.1	0.05861		
	3	3.0	8.6	8.0	8.5	8.4	8.4	0.05449		
2	4	3.0	8.6	8.4	8.1	8.5	8.4	0.05416	8.3	0.05589
	1	3.0	7.5	6.9	7.5	6.9	7.2	0.07372		
	2	3.0	7.2	7.0	7.0	7.3	7.1	0.07528		
	3	3.0	7.2	7.8	7.0	7.5	7.4	0.07026		
3	4	3.0	7.0	7.5	7.4	7.3	7.3	0.07171	7.3	0.07271
	1	3.0	7.0	8.0	7.4	7.6	7.5	0.06794		
	2	3.0	7.5	7.5	7.5	7.6	7.5	0.06749		
	3	3.0	8.0	7.8	7.4	8.2	7.9	0.06202		
4	4	3.0	7.8	8.0	7.9	8.0	7.9	0.06085	7.7	0.06446
	1	3.0	8.0	7.8	7.6	7.9	7.8	0.06241		
	2	3.0	8.1	7.7	7.4	8.2	7.9	0.06202		
	3	3.0	8.5	7.7	8.0	8.0	8.1	0.05897		
5	4	3.0	8.0	7.2	8.2	8.0	7.9	0.06202	7.9	0.06133
						Mean			7.3	0.06404

Figure A-II-2 Summary of Volumetric Macro-Texture Data Collected on 02/17/04, on Test Section #2 (FC-2) in Accordance with ASTM E 965.

Texture Study NBTL/26050/SR-24/FC-5 Oolite										
Lockup Point	Site #	Volume Sand (in^3)	Diameter Number 1 (in)	Diameter Number 2 (in)	Diameter Number 3 (in)	Diameter Number 4 (in)	Mean (in)	MTD (in)	Mean	MTD (in)
	1	3.0	6.9	6.6	6.5	6.5	6.6	0.08707		
	2	3.0	6.5	6.3	6.4	6.5	6.4	0.09258		
	3	3.0	6.5	6.5	6.4	6.1	6.4	0.09404		
1	4	3.0	6.0	6.2	6.2	5.8	6.1	0.10441	6.4	0.09422
	1	3.0	6.5	6.4	6.2	6.5	6.4	0.09330		
	2	3.0	6.5	6.8	6.8	6.6	6.7	0.08577		
	3	3.0	7.0	6.7	6.8	7.2	6.9	0.07969		
2	4	3.0	7.3	7.2	7.0	7.4	7.2	0.07321	6.8	0.08250
	1	3.0	6.5	6.5	6.6	6.6	6.6	0.08908		
	2	3.0	6.4	6.7	6.6	7.0	6.7	0.08577		
	3	3.0	6.4	6.7	6.8	7.0	6.7	0.08450		
3	4	3.0	6.5	7.0	6.8	6.9	6.8	0.08265	6.7	0.08545
	1	3.0	6.4	7.0	6.1	7.0	6.6	0.08707		
	2	3.0	7.2	6.7	6.7	7.1	6.9	0.07969		
	3	3.0	6.9	6.4	6.5	6.4	6.6	0.08908		
4	4	3.0	6.5	6.6	7.0	6.6	6.7	0.08577	6.7	0.08529
	1	3.0	6.4	6.3	6.4	6.3	6.4	0.09478		
	2	3.0	7.0	7.0	7.0	7.3	7.1	0.07635		
	3	3.0	6.9	6.9	7.0	6.5	6.8	0.08204		
5	4	3.0	7.0	7.0	6.6	6.8	6.9	0.08145	6.8	0.08326
						Mean			6.7	0.08614

Figure A-II-3 Summary of Volumetric Macro-Texture Data Collected on 02/17/04, on Test Section #3 (FC-5-Oolite) in Accordance with ASTM E 965.

Texture Study NBTL/26050/SR-24/FC-5 Granite										
Lockup Point	Site #	Volume Sand (in^3)	Diameter Number 1 (in)	Diameter Number 2 (in)	Diameter Number 3 (in)	Diameter Number 4 (in)	Mean (in)	MTD (in)	Mean	MTD (in)
	1	4.5	7.0	6.6	6.5	6.6	6.7	0.12866		
	2	4.5	6.7	6.8	6.6	7.1	6.8	0.12397		
	3	4.5	7.1	7.1	7.5	6.8	7.1	0.11292		
1	4	4.5	7.0	7.2	6.8	7.0	7.0	0.11699	6.9	0.12041
	1	4.5	7.0	7.2	7.0	7.2	7.1	0.11372		
	2	4.5	7.0	7.0	7.2	6.9	7.0	0.11616		
	3	4.5	7.2	6.9	7.0	7.5	7.2	0.11213		
2	4	4.5	7.5	7.5	7.0	8.0	7.5	0.10191	7.2	0.11077
	1	4.5	7.2	6.9	6.7	7.4	7.1	0.11534		
	2	4.5	7.1	6.7	6.7	6.7	6.8	0.12397		
	3	4.5	7.0	6.9	6.6	6.7	6.8	0.12397		
3	4	4.5	6.5	6.6	7.1	6.4	6.7	0.12963	6.8	0.12307
	1	4.5	6.6	6.5	6.6	7.1	6.7	0.12770		
	2	4.5	7.0	6.4	6.5	6.8	6.7	0.12866		
	3	4.5	6.7	6.6	6.5	6.8	6.7	0.12963		
4	4	4.5	7.0	6.6	6.7	7.0	6.8	0.12307	6.7	0.12723
	1	4.5	7.5	7.3	7.4	7.9	7.5	0.10123		
	2	4.5	7.6	7.1	6.8	7.8	7.3	0.10684		
	3	4.5	7.4	7.6	7.7	7.3	7.5	0.10191		
5	4	4.5	7.6	7.3	7.2	7.2	7.3	0.10684	7.4	0.10416
						Mean			7.0	0.11712

Figure A-II-4 Summary of Volumetric Macro-Texture Data Collected on 02/17/04, on Test Section #4 (FC-5-Granite) in Accordance with ASTM E 965.

Texture Study NBTL/26050/SR-24/FC-4										
Lockup Point	Site #	Volume Sand (in^3)	Diameter Number 1 (in)	Diameter Number 2 (in)	Diameter Number 3 (in)	Diameter Number 4 (in)	Mean (in)	MTD (in)	Mean	MTD (in)
	1	1.5	6.5	6.0	6.0	6.3	6.2	0.04971		
	2	1.5	6.0	5.7	6.0	5.8	5.9	0.05536		
	3	1.5	5.6	5.7	6.0	5.9	5.8	0.05680		
1	4	1.5	6.1	5.8	6.4	6.0	6.1	0.05178	6.0	0.05330
	1	1.5	5.9	6.1	5.5	5.7	5.8	0.05680		
	2	1.5	5.5	5.5	5.8	5.8	5.7	0.05986		
	3	1.5	6.0	5.5	6.2	5.5	5.8	0.05680		
2	4	1.5	6.0	5.9	6.0	6.0	6.0	0.05352	5.8	0.05668
	1	1.5	5.4	5.6	5.6	5.6	5.6	0.06203		
	2	1.5	5.7	5.6	5.6	6.2	5.8	0.05730		
	3	1.5	5.6	5.4	5.0	5.7	5.4	0.06493		
3	4	1.5	5.3	5.3	5.0	5.8	5.4	0.06676	5.5	0.06260
	1	1.5	5.2	5.0	5.4	5.2	5.2	0.07067		
	2	1.5	5.4	5.0	5.1	5.0	5.1	0.07275		
	3	1.5	5.0	4.9	4.9	5.1	5.0	0.07720		
4	4	1.5	5.0	5.1	4.8	5.3	5.1	0.07493	5.1	0.07383
	1	1.5	5.4	5.3	5.4	5.0	5.3	0.06867		
	2	1.5	5.6	5.4	5.4	5.6	5.5	0.06317		
	3	1.5	5.9	5.6	5.6	5.7	5.7	0.05881		
5	4	1.5	5.8	5.5	5.5	5.5	5.6	0.06148	5.5	0.06288
						Mean			5.6	0.06186

Figure A-II-5 Summary of Volumetric Macro-Texture Data Collected on 02/17/04, on Test Section #5 (FC-4) in Accordance with ASTM E 965.

8.2.2 64 kHz Laser Texture Test Data, As Collected in accordance with ASTM E 1845-01, "Standard Practice for Calculating Pavement Macrotexture Mean Profile Depth."

ASTM REP 1	DATE 02/17/04		RIB TIRE		40 MPH														
TEST	REF.	CYCLE	FN				SPEED		MTD				%	MPD				IFI	
SECT.	POST	NUM.	AVG	STD	PEAK	VALLEY	AVG	STD	(in)	STD. (in)	(mm)	STD. (mm)	ERROR	(in)	STD. (in)	(mm)	STD. (mm)	F60	Sp
#1 FC-3	0.029	1	3.4	0.21	0	0	39.9	0.03	0.040	0.013	1.019	0.330	0.00	0.040	0.006	1.019	0.159	0.1	104.1
	0.140	2	3.5	0.23	0	0	40.2	0.04	0.038	0.011	0.963	0.286	0.00	0.037	0.004	0.950	0.103	0.0	97.8
	0.233	3	3.4	0.23	0	0	40.2	0.03	0.040	0.013	1.025	0.321	0.00	0.040	0.006	1.027	0.147	0.2	104.9
	0.315	4	3.4	0.21	0	0	39.8	0.03	0.045	0.015	1.139	0.373	0.00	0.046	0.008	1.170	0.212	1.4	117.8
	0.454	5	3.4	0.22	0	0	40.0	0.04	0.045	0.015	1.140	0.376	0.00	0.046	0.009	1.171	0.216	1.4	117.9
	N		5				5		5		5			5		5		5	5
	Mean		**3.4**				**40.0**		**0.042**		**1.057**			**0.042**		**1.067**		**0.6**	**108.5**
	Std.		0.0				0.2		0.003		0.079			0.004		0.099		0.7	9.0
	Hi		3.5				40.2		0.045		1.140			0.046		1.171		1.4	117.9
	Lo		3.4				39.8		0.038		0.963			0.037		0.950		0.0	97.8
#2 FC-2	1.136	6	3.3	0.24	0	0	40.0	0.04	0.128	0.026	3.250	0.651	1.81	0.150	0.022	3.808	0.559	23.5	357.6
	1.225	7	3.3	0.22	0	0	40.3	0.04	0.114	0.026	2.904	0.667	1.64	0.133	0.023	3.376	0.580	19.9	318.3
	1.316	8	3.3	0.21	0	0	40.2	0.03	0.121	0.031	3.071	0.776	2.26	0.141	0.028	3.585	0.715	21.6	337.3
	1.407	9	3.3	0.22	0	0	40.2	0.04	0.132	0.028	3.356	0.698	2.75	0.155	0.024	3.940	0.618	24.6	369.6
	1.496	10	3.3	0.24	0	0	39.8	0.04	0.122	0.033	3.108	0.836	1.61	0.143	0.031	3.631	0.792	22.0	341.4
	N		5				5		5		5			5		5		5	5
	Mean		**3.3**				**40.1**		**0.123**		**3.138**			**0.144**		**3.668**		**22.3**	**344.8**
	Std.		0.0				0.2		0.007		0.173			0.008		0.216		1.8	19.7
	Hi		3.3				40.3		0.132		3.356			0.155		3.940		24.6	369.6
	Lo		3.3				39.8		0.114		2.904			0.133		3.376		19.9	318.3
#3 FC-5-OO	6.857	11	3.3	0.22	0	0	40.3	0.03	0.137	0.033	3.471	0.837	5.22	0.161	0.031	4.085	0.792	25.8	382.8
	6.964	12	3.2	0.24	0	0	40.1	0.04	0.151	0.043	3.830	1.100	4.83	0.178	0.044	4.533	1.121	29.6	423.5
	7.064	13	3.3	0.24	0	0	39.9	0.04	0.139	0.032	3.527	0.806	4.98	0.164	0.030	4.154	0.753	26.4	389.0
	7.154	14	3.2	0.24	0	0	40.0	0.04	0.142	0.036	3.619	0.924	3.83	0.168	0.036	4.270	0.901	27.4	399.5
	7.246	15	3.2	0.28	0	0	40.3	0.03	0.147	0.036	3.746	0.908	4.60	0.174	0.035	4.429	0.881	28.7	414.0
	N		5				5		5		5			5		5		5	5
	Mean		**3.2**				**40.1**		**0.143**		**3.639**			**0.169**		**4.294**		**27.6**	**401.8**
	Std.		0.1				0.2		0.006		0.149			0.007		0.187		1.6	17.0
	Hi		3.3				40.3		0.151		3.830			0.178		4.533		29.6	423.5
	Lo		3.2				39.9		0.137		3.471			0.161		4.085		25.8	382.8
#4 FC-5-GR	9.580	16	3.1	0.26	0	0	40.3	0.05	0.176	0.046	4.481	1.166	5.21	0.211	0.047	5.347	1.204	36.4	497.4
	9.684	17	3.1	0.28	0	0	40.2	0.03	0.178	0.051	4.525	1.301	4.24	0.213	0.054	5.402	1.373	36.9	502.4
	9.762	18	3.1	0.27	0	0	39.9	0.03	0.181	0.047	4.593	1.188	4.51	0.216	0.049	5.487	1.232	37.6	510.2
	9.846	19	3.1	0.27	0	0	39.9	0.03	0.159	0.037	4.041	0.951	4.02	0.189	0.037	4.797	0.935	31.8	447.4
	9.944	20	3.1	0.27	0	0	40.1	0.03	0.183	0.058	4.649	1.465	4.23	0.219	0.062	5.558	1.577	38.2	516.6
	N		5				5		5		5			5		5		5	5
	Mean		**3.1**				**40.1**		**0.175**		**4.458**			**0.210**		**5.318**		**36.2**	**494.8**
	Std.		0.0				0.2		0.010		0.242			0.012		0.302		2.5	27.5
	Hi		3.1				40.3		0.183		4.649			0.219		5.558		38.2	516.6
	Lo		3.1				39.9		0.159		4.041			0.189		4.797		31.8	447.4
#5 FC-4	19.778	21	2.7	0.25	0	0	40.4	0.04	0.049	0.015	1.243	0.380	0.00	0.051	0.009	1.300	0.221	2.5	129.6
	19.848	22	2.5	0.24	0	0	40.3	0.03	0.049	0.014	1.247	0.346	0.02	0.051	0.007	1.305	0.179	2.5	130.1
	19.920	23	2.7	0.26	0	0	40.2	0.06	0.059	0.018	1.506	0.451	0.02	0.064	0.012	1.628	0.310	5.2	159.4
	19.989	24	2.5	0.25	0	0	40.5	0.04	0.052	0.013	1.314	0.328	0.03	0.055	0.006	1.389	0.155	3.2	137.7
	20.059	25	2.5	0.26	0	0	39.9	0.05	0.051	0.015	1.306	0.375	0.01	0.054	0.009	1.379	0.215	3.1	136.8
	N		5				5		5		5			5		5		5	5
	Mean		**2.6**				**40.3**		**0.052**		**1.323**			**0.055**		**1.400**		**3.3**	**138.7**
	Std.		0.1				0.2		0.004		0.107			0.005		0.134		1.1	12.1
	Hi		2.7				40.5		0.059		1.506			0.064		1.628		5.2	159.4
	Lo		2.5				39.9		0.049		1.243			0.051		1.300		2.5	129.6

Figure A-II-6 **Summary of Laser Texture Data Collected on 02/17/04, 40 MPH, No Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).**

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\26.K01
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR DIR Asc (+) LANE 1
OPERATOR AMS DRIVER AMS VEHICLE UNIT#7 EQUIPMENT MD4040/R
CO-SEC&LEG 26 FIN_NO. TEST SECTIONS REQ_TYPE 3
DATE 02/17/2004 TIME 16:17:04 **TIRE Rib**
AIR_TEMPERATURE 47.0øF CONDITIONS DAY/CLOUDY

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
0.029	1	**3.4**	0.21	0.0	0.0	**39.9**	0.03	0.040	0.0130	1.019	0.330	0.00	0.040	0.0063	1.019	0.159	0.1	104.1
0.140	2	3.5	0.23	0.0	0.0	40.2	0.04	0.038	0.0113	0.963	0.286	0.00	0.037	0.0041	0.950	0.103	0.0	97.8
0.233	3	3.4	0.23	0.0	0.0	40.2	0.03	0.040	0.0126	1.025	0.321	0.00	0.040	0.0058	1.027	0.147	0.2	104.9
0.315	4	3.4	0.21	0.0	0.0	39.8	0.03	0.045	0.0147	1.139	0.373	0.00	0.046	0.0083	1.170	0.212	1.4	117.8
0.454	5	3.4	0.22	0.0	0.0	40.0	0.04	0.045	0.0148	1.140	0.376	0.00	0.046	0.0085	1.171	0.216	1.4	117.9

MTD (mm) M = 1.057 SD = 0.0792 H = 1.140 L = 0.963
MPD (mm) M = 1.068 SD = 0.0989 H = 1.171 L = 0.950
Left Wheel N = 5 M = 3.4 SD = 0.05 H = 3.5 L = 3.4

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
1.136	6	3.3	0.24	0.0	0.0	40.0	0.04	0.128	0.0256	3.250	0.651	1.81	0.150	0.0220	3.808	0.559	23.5	357.6
1.225	7	3.3	0.22	0.0	0.0	40.3	0.04	0.114	0.0263	2.904	0.667	1.64	0.133	0.0228	3.376	0.580	19.9	318.3
1.316	8	3.3	0.21	0.0	0.0	40.2	0.03	0.121	0.0305	3.071	0.776	2.26	0.141	0.0282	3.585	0.715	21.6	337.3
1.407	9	3.3	0.22	0.0	0.0	40.2	0.04	0.132	0.0275	3.356	0.698	2.75	0.155	0.0243	3.940	0.618	24.6	369.6
1.496	10	3.3	0.24	0.0	0.0	39.8	0.04	0.122	0.0329	3.108	0.836	1.61	0.143	0.0312	3.631	0.792	22.0	341.4

MTD (mm) M = 3.138 SD = 0.1732 H = 3.356 L = 2.904
MPD (mm) M = 3.668 SD = 0.2165 H = 3.940 L = 3.376
Left Wheel N = 5 M = 3.3 SD = 0.03 H = 3.3 L = 3.3

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
6.857	11	3.3	0.22	0.0	0.0	40.3	0.03	0.137	0.0329	3.471	0.837	5.22	0.161	0.0312	4.085	0.792	25.8	382.8
6.964	12	3.2	0.24	0.0	0.0	40.1	0.04	0.151	0.0433	3.830	1.100	4.83	0.178	0.0441	4.533	1.121	29.6	423.5
7.064	13	3.3	0.24	0.0	0.0	39.9	0.04	0.139	0.0317	3.527	0.806	4.98	0.164	0.0296	4.154	0.753	26.4	389.0
7.154	14	3.2	0.24	0.0	0.0	40.0	0.04	0.142	0.0364	3.619	0.924	3.83	0.168	0.0355	4.270	0.901	27.4	399.5
7.246	15	3.2	0.28	0.0	0.0	40.3	0.03	0.147	0.0358	3.746	0.908	4.60	0.174	0.0347	4.429	0.881	28.7	414.0

MTD (mm) M = 3.639 SD = 0.1491 H = 3.830 L = 3.471
MPD (mm) M = 4.294 SD = 0.1864 H = 4.533 L = 4.085
Left Wheel N = 5 M = 3.2 SD = 0.06 H = 3.3 L = 3.2

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
9.580	16	3.1	0.26	0.0	0.0	40.3	0.05	0.176	0.0459	4.481	1.166	5.21	0.211	0.0474	5.347	1.204	36.4	497.4
9.684	17	3.1	0.28	0.0	0.0	40.2	0.03	0.178	0.0512	4.525	1.301	4.24	0.213	0.0540	5.402	1.373	36.9	502.4
9.762	18	3.1	0.27	0.0	0.0	39.9	0.03	0.181	0.0468	4.593	1.188	4.51	0.216	0.0485	5.487	1.232	37.6	510.2
9.846	19	3.1	0.27	0.0	0.0	39.9	0.03	0.159	0.0374	4.041	0.951	4.02	0.189	0.0368	4.797	0.935	31.8	447.4
9.944	20	3.1	0.27	0.0	0.0	40.1	0.03	0.183	0.0577	4.649	1.465	4.23	0.219	0.0621	5.558	1.577	38.2	516.6

MTD (mm) M = 4.458 SD = 0.2419 H = 4.649 L = 4.041
MPD (mm) M = 5.318 SD = 0.3024 H = 5.558 L = 4.797
Left Wheel N = 5 M = 3.1 SD = 0.02 H = 3.1 L = 3.1

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
19.778	21	2.7	0.25	0.0	0.0	40.4	0.04	0.049	0.0150	1.243	0.380	0.00	0.051	0.0087	1.300	0.221	2.5	129.6
19.848	22	2.5	0.24	0.0	0.0	40.3	0.03	0.049	0.0136	1.247	0.346	0.02	0.051	0.0070	1.305	0.179	2.5	130.1
19.920	23	2.7	0.26	0.0	0.0	40.2	0.06	0.059	0.0178	1.506	0.451	0.02	0.064	0.0122	1.628	0.310	5.2	159.4
19.989	24	2.5	0.25	0.0	0.0	40.5	0.04	0.052	0.0129	1.314	0.328	0.03	0.055	0.0061	1.389	0.155	3.2	137.7
20.059	25	2.5	0.26	0.0	0.0	39.9	0.05	0.051	0.0148	1.306	0.375	0.01	0.054	0.0085	1.379	0.215	3.1	136.8

MTD (mm) M = 1.323 SD = 0.1071 H = 1.506 L = 1.243
MPD (mm) M = 1.400 SD = 0.1338 H = 1.628 L = 1.300
Left Wheel N = 5 M = 2.6 SD = 0.10 H = 2.7 L = 2.5

ASTM REP 2	DATE 02/17/04		RIB TIRE		40 MPH														
TEST	REF.	CYCLE	FN				SPEED		MTD				%	MPD				IFI	
SECT.	POST	NUM.	AVG	STD	PEAK	VALLEY	AVG	STD	(in)	STD. (in)	(mm)	STD. (mm)	ERROR	(in)	STD. (in)	(mm)	STD. (mm)	F60	Sp
#1 FC-3	0.019	1	36.4	0.67	74.4	24.8	40.2	0.09	0.042	0.013	1.060	0.320	0.00	0.042	0.006	1.071	0.146	0.5	108.8
	0.128	2	37.0	0.57	66.8	22.3	40.0	0.10	0.043	0.013	1.084	0.323	0.00	0.043	0.006	1.101	0.150	0.8	111.5
	0.221	3	37.0	0.28	59.4	19.7	40.1	0.04	0.041	0.012	1.038	0.316	0.00	0.041	0.006	1.044	0.141	0.3	106.4
	0.301	4	36.7	0.41	57.7	19.3	39.8	0.09	0.046	0.016	1.164	0.398	0.00	0.047	0.010	1.201	0.244	1.6	120.6
	0.442	5	35.8	0.43	57.5	19.2	39.6	0.05	0.043	0.013	1.097	0.335	0.00	0.044	0.007	1.117	0.164	0.9	113.0
	N		5				5		5		5			5		5		5	5
	Mean		**36.6**				**39.9**		**0.043**		**1.089**			**0.043**		**1.107**		**0.8**	**112.1**
	Std.		0.5				0.2		0.002		0.048			0.002		0.060		0.5	5.4
	Hi		37.0				40.2		0.046		1.164			0.047		1.201		1.6	120.6
	Lo		35.8				39.6		0.041		1.038			0.041		1.044		0.3	106.4
#2 FC-2	1.121	6	35.7	0.38	69.0	23.0	39.9	0.07	0.119	0.032	3.033	0.807	1.68	0.139	0.030	3.538	0.754	21.2	333.0
	1.210	7	35.3	0.44	53.9	18.0	40.2	0.05	0.115	0.036	2.930	0.901	1.22	0.134	0.034	3.408	0.872	20.2	321.2
	1.300	8	37.2	0.37	52.7	17.6	40.1	0.05	0.124	0.031	3.159	0.775	1.59	0.145	0.028	3.695	0.714	22.6	347.3
	1.388	9	34.8	0.48	50.3	16.8	40.2	0.04	0.127	0.035	3.236	0.876	2.14	0.149	0.033	3.792	0.841	23.4	356.1
	1.481	10	34.4	0.71	49.3	16.5	40.1	0.11	0.118	0.028	2.986	0.710	1.71	0.137	0.025	3.479	0.633	20.8	327.6
	N		5				5		5		5			5		5		5	5
	Mean		**35.5**				**40.1**		**0.121**		**3.069**			**0.141**		**3.582**		**21.6**	**337.0**
	Std.		1.1				0.1		0.005		0.126			0.006		0.158		1.3	14.4
	Hi		37.2				40.2		0.127		3.236			0.149		3.792		23.4	356.1
	Lo		34.4				39.9		0.115		2.930			0.134		3.408		20.2	321.2
#3 FC-5-OO	6.839	11	37.0	0.63	73.9	24.6	39.5	0.04	0.149	0.043	3.794	1.093	3.66	0.177	0.044	4.489	1.112	29.2	419.4
	6.944	12	35.2	0.91	59.5	19.9	40.0	0.06	0.140	0.037	3.564	0.947	3.68	0.165	0.037	4.200	0.930	26.8	393.2
	7.044	13	34.2	0.73	55.6	18.6	39.9	0.16	0.133	0.032	3.371	0.816	3.72	0.156	0.030	3.960	0.765	24.8	371.4
	7.135	14	33.3	1.24	51.1	17.1	40.3	0.05	0.130	0.032	3.293	0.814	3.62	0.152	0.030	3.862	0.763	24.0	362.5
	7.228	15	37.0	1.00	55.9	18.7	39.8	0.03	0.139	0.031	3.518	0.786	4.13	0.163	0.029	4.144	0.728	26.3	388.1
	N		5				5		5		5			5		5		5	5
	Mean		**35.3**				**39.9**		**0.138**		**3.508**			**0.163**		**4.131**		**26.2**	**386.9**
	Std.		1.7				0.3		0.007		0.194			0.010		0.242		2.0	22.0
	Hi		37.0				40.3		0.149		3.794			0.177		4.489		29.2	419.4
	Lo		33.3				39.5		0.130		3.293			0.152		3.862		24.0	362.5
#4 FC-5-GR	9.559	16	43.2	1.01	78.1	26.1	40.2	0.09	0.188	0.051	4.785	1.300	4.21	0.225	0.054	5.727	1.372	39.6	532.0
	9.669	17	43.5	0.53	69.9	23.3	39.9	0.03	0.179	0.044	4.535	1.112	4.64	0.213	0.045	5.415	1.136	37.0	503.6
	9.743	18	43.5	0.92	68.5	22.9	40.1	0.10	0.194	0.047	4.938	1.204	4.32	0.233	0.049	5.918	1.251	41.2	549.3
	9.827	19	43.2	0.60	65.7	21.9	40.0	0.03	0.185	0.041	4.693	1.041	4.42	0.221	0.041	5.613	1.048	38.7	521.6
	9.928	20	43.2	0.67	67.7	22.6	40.3	0.12	0.175	0.050	4.453	1.275	4.22	0.209	0.053	5.312	1.339	36.2	494.3
	N		5				5		5		5			5		5		5	5
	Mean		**43.3**				**40.1**		**0.184**		**4.681**			**0.220**		**5.597**		**38.5**	**520.2**
	Std.		0.2				0.2		0.007		0.194			0.010		0.242		2.0	22.0
	Hi		43.5				40.3		0.194		4.938			0.233		5.918		41.2	549.3
	Lo		43.2				39.9		0.175		4.453			0.209		5.312		36.2	494.3
#5 FC-4	19.755	21	51.1	0.83	91.6	30.6	40.2	0.14	0.049	0.013	1.256	0.327	0.00	0.052	0.006	1.316	0.154	2.6	131.1
	19.825	22	48.4	0.98	82.2	27.5	40.5	0.08	0.049	0.015	1.241	0.372	0.02	0.051	0.008	1.297	0.211	2.4	129.4
	19.897	23	53.9	1.27	83.4	27.8	40.0	0.05	0.055	0.014	1.396	0.344	0.00	0.059	0.007	1.491	0.176	4.1	147.0
	19.965	24	50.6	0.98	79.3	26.5	40.2	0.12	0.054	0.015	1.363	0.385	0.01	0.057	0.009	1.450	0.227	3.7	143.2
	20.036	25	52.3	0.74	80.8	26.9	40.1	0.10	0.052	0.015	1.318	0.373	0.02	0.055	0.008	1.394	0.212	3.2	138.1
	N		5				5		5		5			5		5		5	5
	Mean		**51.3**				**40.2**		**0.052**		**1.315**			**0.055**		**1.390**		**3.2**	**137.8**
	Std.		2.0				0.2		0.003		0.067			0.003		0.084		0.7	7.6
	Hi		53.9				40.5		0.055		1.396			0.059		1.491		4.1	147.0
	Lo		48.4				40.0		0.049		1.241			0.051		1.297		2.4	129.4

Figure A-II-7 **Summary of Laser Texture Data Collected on 02/17/04, 40 MPH, with Ribbed Tire Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).**

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\26.K02
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR DIR Asc (+) LANE 1
OPERATOR AMS DRIVER AMS VEHICLE UNIT#7 EQUIPMENT MD4040/R
CO-SEC&LEG 26 FIN_NO. TEST SECTIONS REQ_TYPE 3
DATE 02/17/2004 TIME 16:53:44 **TIRE Rib**
AIR_TEMPERATURE 47.0øF CONDITIONS DAY/CLOUDY

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
0.019	1	**36.4**	0.67	74.4	24.8	**40.2**	0.09	0.042	0.0126	1.060	0.320	0.00	0.042	0.0057	1.071	0.146	0.5	108.8
0.128	2	37.0	0.57	66.8	22.3	40.0	0.10	0.043	0.0127	1.084	0.323	0.00	0.043	0.0059	1.101	0.150	0.8	111.5
0.221	3	37.0	0.28	59.4	19.7	40.1	0.04	0.041	0.0124	1.038	0.316	0.00	0.041	0.0055	1.044	0.141	0.3	106.4
0.301	4	36.7	0.41	57.7	19.3	39.8	0.09	0.046	0.0157	1.164	0.398	0.00	0.047	0.0096	1.201	0.244	1.6	120.6
0.442	5	35.8	0.43	57.5	19.2	39.6	0.05	0.043	0.0132	1.097	0.335	0.00	0.044	0.0065	1.117	0.164	0.9	113.0

MTD (mm) M = 1.089 SD = 0.0478 H = 1.164 L = 1.038
MPD (mm) M = 1.107 SD = 0.0598 H = 1.201 L = 1.044
Left Wheel N = 5 M = 36.6 SD = 0.51 H = 37.0 L = 35.8

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
1.121	6	35.7	0.38	69.0	23.0	39.9	0.07	0.119	0.0318	3.033	0.807	1.68	0.139	0.0297	3.538	0.754	21.2	333.0
1.210	7	35.3	0.44	53.9	18.0	40.2	0.05	0.115	0.0355	2.930	0.901	1.22	0.134	0.0343	3.408	0.872	20.2	321.2
1.300	8	37.2	0.37	52.7	17.6	40.1	0.05	0.124	0.0305	3.159	0.775	1.59	0.145	0.0281	3.695	0.714	22.6	347.3
1.388	9	34.8	0.48	50.3	16.8	40.2	0.04	0.127	0.0345	3.236	0.876	2.14	0.149	0.0331	3.792	0.841	23.4	356.1
1.481	10	34.4	0.71	49.3	16.5	40.1	0.11	0.118	0.0279	2.986	0.710	1.71	0.137	0.0249	3.479	0.633	20.8	327.6

MTD (mm) M = 3.069 SD = 0.1262 H = 3.236 L = 2.930
MPD (mm) M = 3.582 SD = 0.1578 H = 3.792 L = 3.408
Left Wheel N = 5 M = 35.5 SD = 1.08 H = 37.2 L = 34.4

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
6.839	11	37.0	0.63	73.9	24.6	39.5	0.04	0.149	0.0430	3.794	1.093	3.66	0.177	0.0438	4.489	1.112	29.2	419.4
6.944	12	35.2	0.91	59.5	19.9	40.0	0.06	0.140	0.0373	3.564	0.947	3.68	0.165	0.0366	4.200	0.930	26.8	393.2
7.044	13	34.2	0.73	55.6	18.6	39.9	0.16	0.133	0.0321	3.371	0.816	3.72	0.156	0.0301	3.960	0.765	24.8	371.4
7.135	14	33.3	1.24	51.1	17.1	40.3	0.05	0.130	0.0320	3.293	0.814	3.62	0.152	0.0300	3.862	0.763	24.0	362.5
7.228	15	37.0	1.00	55.9	18.7	39.8	0.03	0.139	0.0309	3.518	0.786	4.13	0.163	0.0287	4.144	0.728	26.3	388.1

MTD (mm) M = 3.508 SD = 0.1936 H = 3.794 L = 3.293
MPD (mm) M = 4.131 SD = 0.2420 H = 4.489 L = 3.862
Left Wheel N = 5 M = 35.3 SD = 1.66 H = 37.0 L = 33.3

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
9.559	16	43.2	1.01	78.1	26.1	40.2	0.09	0.188	0.0512	4.785	1.300	4.21	0.225	0.0540	5.727	1.372	39.6	532.0
9.669	17	43.5	0.53	69.9	23.3	39.9	0.03	0.179	0.0438	4.535	1.112	4.64	0.213	0.0447	5.415	1.136	37.0	503.6
9.743	18	43.5	0.92	68.5	22.9	40.1	0.10	0.194	0.0474	4.938	1.204	4.32	0.233	0.0493	5.918	1.251	41.2	549.3
9.827	19	43.2	0.60	65.7	21.9	40.0	0.03	0.185	0.0410	4.693	1.041	4.42	0.221	0.0412	5.613	1.048	38.7	521.6
9.928	20	43.2	0.67	67.7	22.6	40.3	0.12	0.175	0.0502	4.453	1.275	4.22	0.209	0.0527	5.312	1.339	36.2	494.3

MTD (mm) M = 4.681 SD = 0.1938 H = 4.938 L = 4.453
MPD (mm) M = 5.597 SD = 0.2423 H = 5.918 L = 5.312
Left Wheel N = 5 M = 43.3 SD = 0.18 H = 43.5 L = 43.2

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
19.755	21	51.1	0.83	91.6	30.6	40.2	0.14	0.049	0.0129	1.256	0.327	0.00	0.052	0.0061	1.316	0.154	2.6	131.1
19.825	22	48.4	0.98	82.2	27.5	40.5	0.08	0.049	0.0146	1.241	0.372	0.02	0.051	0.0083	1.297	0.211	2.4	129.4
19.897	23	53.9	1.27	83.4	27.8	40.0	0.05	0.055	0.0135	1.396	0.344	0.00	0.059	0.0069	1.491	0.176	4.1	147.0
19.965	24	50.6	0.98	79.3	26.5	40.2	0.12	0.054	0.0152	1.363	0.385	0.01	0.057	0.0089	1.450	0.227	3.7	143.2
20.036	25	52.3	0.74	80.8	26.9	40.1	0.10	0.052	0.0147	1.318	0.373	0.02	0.055	0.0084	1.394	0.212	3.2	138.1

MTD (mm) M = 1.315 SD = 0.0667 H = 1.396 L = 1.241
MPD (mm) M = 1.389 SD = 0.0834 H = 1.491 L = 1.297
Left Wheel N = 5 M = 51.3 SD = 2.06 H = 53.9 L = 48.4

ASTM REP 1	DATE 02/18/04		BLANK TIRE		40 MPH														
TEST	REF.	CYCLE	FN				SPEED		MTD				%	MPD				IFI	
SECT.	POST	NUM.	AVG	STD	PEAK	VALLEY	AVG	STD	(in)	STD. (in)	(mm)	STD. (mm)	ERROR	(in)	STD. (in)	(mm)	STD. (mm)	F60	Sp
#1 FC-3	0.017	1	26.5	1.53	52.2	17.4	39.6	0.08	0.039	0.012	0.994	0.313	0.01	0.039	0.005	0.989	0.138	3.5	101.3
	0.128	2	28.2	0.34	48.8	16.2	39.8	0.04	0.041	0.013	1.051	0.321	0.00	0.042	0.006	1.059	0.148	3.5	107.7
	0.222	3	26.8	0.82	44.9	15.0	40.1	0.06	0.041	0.014	1.040	0.344	0.00	0.041	0.007	1.046	0.175	3.5	106.5
	0.302	4	28.3	0.92	44.4	14.8	39.9	0.07	0.043	0.013	1.086	0.324	0.00	0.043	0.006	1.103	0.151	3.5	111.7
	0.443	5	27.4	0.81	43.3	14.5	39.7	0.05	0.046	0.015	1.168	0.387	0.00	0.047	0.009	1.206	0.229	3.5	121.1
	N		5				5		5		5			5		5		5	5
	Mean		**27.4**				**39.8**		**0.042**		**1.068**			**0.042**		**1.081**		**3.5**	**109.7**
	Std.		0.8				0.2		0.003		0.065			0.003		0.081		0.0	7.4
	Hi		28.3				40.1		0.046		1.168			0.047		1.206		3.5	121.1
	Lo		26.5				39.6		0.039		0.994			0.039		0.989		3.5	101.3
#2 FC-2	1.124	6	32.4	0.57	60.2	20.1	40.2	0.09	0.122	0.033	3.088	0.845	1.57	0.142	0.032	3.606	0.802	3.5	339.2
	1.213	7	32.5	0.33	47.7	15.9	40.1	0.03	0.117	0.031	2.976	0.797	1.31	0.136	0.029	3.466	0.742	3.5	326.5
	1.303	8	34.2	0.35	48.8	16.3	40.0	0.07	0.124	0.029	3.157	0.731	2.16	0.145	0.026	3.692	0.660	3.5	347.0
	1.393	9	31.6	0.45	45.1	15.1	40.0	0.07	0.126	0.029	3.202	0.746	1.96	0.148	0.027	3.749	0.679	3.5	352.2
	1.484	10	31.7	0.42	44.1	14.7	39.9	0.05	0.129	0.032	3.286	0.813	1.77	0.152	0.030	3.853	0.762	3.5	361.6
	N		5				5		5		5			5		5		5	5
	Mean		**32.5**				**40.0**		**0.124**		**3.142**			**0.145**		**3.673**		**3.5**	**345.3**
	Std.		1.0				0.1		0.005		0.117			0.006		0.147		0.0	13.3
	Hi		34.2				40.2		0.129		3.286			0.152		3.853		3.5	361.6
	Lo		31.6				39.9		0.117		2.976			0.136		3.466		3.5	326.5
#3 FC-5-OO	6.848	11	34.8	0.74	65.9	22.0	40.0	0.12	0.151	0.040	3.842	1.014	3.87	0.179	0.040	4.549	1.013	3.5	424.9
	6.954	12	32.9	0.54	53.8	17.9	39.9	0.04	0.135	0.040	3.424	1.021	2.80	0.158	0.040	4.026	1.023	3.5	377.3
	7.053	13	32.8	0.79	50.7	16.9	39.9	0.05	0.132	0.034	3.341	0.859	3.03	0.154	0.032	3.922	0.820	3.5	367.9
	7.145	14	32.1	0.68	47.7	15.9	40.0	0.07	0.131	0.031	3.325	0.796	3.14	0.154	0.029	3.902	0.741	3.5	366.1
	7.237	15	34.4	0.47	53.3	17.8	40.3	0.04	0.142	0.038	3.618	0.965	3.52	0.168	0.038	4.269	0.952	3.5	399.4
	N		5				5		5		5			5		5		5	5
	Mean		**33.4**				**40.0**		**0.138**		**3.510**			**0.163**		**4.134**		**3.5**	**387.1**
	Std.		1.1				0.2		0.008		0.219			0.011		0.274		0.0	24.9
	Hi		34.8				40.3		0.151		3.842			0.179		4.549		3.5	424.9
	Lo		32.1				39.9		0.131		3.325			0.154		3.902		3.5	366.1
#4 FC-5-GR	9.569	16	38.9	0.79	70.1	23.4	39.8	0.06	0.163	0.037	4.151	0.951	4.01	0.194	0.037	4.935	0.935	3.5	460.0
	9.675	17	36.5	0.96	57.7	19.3	40.2	0.07	0.169	0.049	4.304	1.232	3.07	0.202	0.051	5.126	1.286	3.5	477.3
	9.752	18	38.9	0.60	60.2	20.1	40.1	0.14	0.187	0.047	4.744	1.198	4.38	0.223	0.049	5.676	1.243	3.5	527.3
	9.835	19	37.0	0.68	55.4	18.5	40.1	0.06	0.171	0.043	4.342	1.098	4.34	0.204	0.044	5.173	1.119	3.5	481.6
	9.936	20	37.8	0.83	56.2	18.7	40.4	0.04	0.165	0.039	4.191	0.993	4.49	0.196	0.039	4.985	0.988	3.5	464.5
	N		5				5		5		5			5		5		5	5
	Mean		**37.8**				**40.1**		**0.171**		**4.346**			**0.204**		**5.179**		**3.5**	**482.1**
	Std.		1.1				0.2		0.009		0.236			0.011		0.295		0.0	26.8
	Hi		38.9				40.4		0.187		4.744			0.223		5.676		3.5	527.3
	Lo		36.5				39.8		0.163		4.151			0.194		4.935		3.5	460.0
#5 FC-4	19.774	21	40.9	0.67	72.2	24.1	40.0	0.05	0.049	0.011	1.237	0.289	0.02	0.051	0.004	1.293	0.107	3.5	129.0
	19.844	22	40.1	0.69	62.8	20.9	40.1	0.04	0.047	0.012	1.198	0.316	0.01	0.049	0.006	1.244	0.141	3.5	124.5
	19.915	23	42.7	0.93	62.4	20.8	40.0	0.04	0.055	0.018	1.405	0.450	0.05	0.059	0.012	1.503	0.308	3.5	148.1
	19.983	24	41.6	0.73	62.4	20.8	41.0	0.20	0.052	0.014	1.329	0.345	0.02	0.055	0.007	1.408	0.177	3.5	139.4
	20.054	25	41.7	0.76	61.1	20.4	40.0	0.09	0.049	0.013	1.252	0.335	0.01	0.052	0.007	1.312	0.165	3.5	130.7
	N		5				5		5		5			5		5		5	5
	Mean		**41.4**				**40.2**		**0.050**		**1.284**			**0.053**		**1.352**		**3.5**	**134.3**
	Std.		1.0				0.4		0.003		0.083			0.004		0.103		0.0	9.4
	Hi		42.7				41.0		0.055		1.405			0.059		1.503		3.5	148.1
	Lo		40.1				40.0		0.047		1.198			0.049		1.244		3.5	124.5

Figure A-II-8 Summary of Laser Texture Data Collected on 02/18/04, 40 MPH, with Blank Tire Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\26.K03
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR DIR Asc (+) LANE 1
OPERATOR AMS DRIVER AMS VEHICLE UNIT#7 EQUIPMENT MD4040/S
CO-SEC&LEG 26 FIN_NO. TEST SECTIONS REQ_TYPE 3
DATE 02/18/2004 TIME 10:20:34 **TIRE Smooth**
AIR_TEMPERATURE 50.0øF CONDITIONS DAY/CLEAR

REF CYCLE **FN** FN FN FN **SPEED** SPEED IN IN MM MM % IN IN MM MM
POST NUMBER AVG STD PEAK VALLEY AVG STD MTD MTD Std MTD MTD Std Error MPD MPD Std
MPD MPD Std F60 SP

0.017	1	**26.5**	1.53	52.2	17.4	**39.6**	0.08	0.039	0.0123	0.994	0.313	0.01	0.039	0.0054	0.989	0.138	3.5	101.3
0.128	2	28.2	0.34	48.8	16.2	39.8	0.04	0.041	0.0127	1.051	0.321	0.00	0.042	0.0058	1.059	0.148	3.5	107.7
0.222	3	26.8	0.82	44.9	15.0	40.1	0.06	0.041	0.0135	1.040	0.344	0.00	0.041	0.0069	1.046	0.175	3.5	106.5
0.302	4	28.3	0.92	44.4	14.8	39.9	0.07	0.043	0.0128	1.086	0.324	0.00	0.043	0.0059	1.103	0.151	3.5	111.7
0.443	5	27.4	0.81	43.3	14.5	39.7	0.05	0.046	0.0152	1.168	0.387	0.00	0.047	0.0090	1.206	0.229	3.5	121.1

MTD (mm) M = 1.068 SD = 0.0651 H = 1.168 L = 0.994
MPD (mm) M = 1.081 SD = 0.0813 H = 1.206 L = 0.989
Left Wheel N = 5 M = 27.4 SD = 0.81 H = 28.3 L = 26.5

1.124	6	32.4	0.57	60.2	20.1	40.2	0.09	0.122	0.0333	3.088	0.845	1.57	0.142	0.0316	3.606	0.802	3.5	339.2
1.213	7	32.5	0.33	47.7	15.9	40.1	0.03	0.117	0.0314	2.976	0.797	1.31	0.136	0.0292	3.466	0.742	3.5	326.5
1.303	8	34.2	0.35	48.8	16.3	40.0	0.07	0.124	0.0288	3.157	0.731	2.16	0.145	0.0260	3.692	0.660	3.5	347.0
1.393	9	31.6	0.45	45.1	15.1	40.0	0.07	0.126	0.0294	3.202	0.746	1.96	0.148	0.0267	3.749	0.679	3.5	352.2
1.484	10	31.7	0.42	44.1	14.7	39.9	0.05	0.129	0.0320	3.286	0.813	1.77	0.152	0.0300	3.853	0.762	3.5	361.6

MTD (mm) M = 3.142 SD = 0.1171 H = 3.286 L = 2.976
MPD (mm) M = 3.673 SD = 0.1463 H = 3.853 L = 3.466
Left Wheel N = 5 M = 32.5 SD = 1.06 H = 34.2 L = 31.6

6.848	11	34.8	0.74	65.9	22.0	40.0	0.12	0.151	0.0399	3.842	1.014	3.87	0.179	0.0399	4.549	1.013	3.5	424.9
6.954	12	32.9	0.54	53.8	17.9	39.9	0.04	0.135	0.0402	3.424	1.021	2.80	0.158	0.0403	4.026	1.023	3.5	377.3
7.053	13	32.8	0.79	50.7	16.9	39.9	0.05	0.132	0.0338	3.341	0.859	3.03	0.154	0.0323	3.922	0.820	3.5	367.9
7.145	14	32.1	0.68	47.7	15.9	40.0	0.07	0.131	0.0313	3.325	0.796	3.14	0.154	0.0292	3.902	0.741	3.5	366.1
7.237	15	34.4	0.47	53.3	17.8	40.3	0.04	0.142	0.0380	3.618	0.965	3.52	0.168	0.0375	4.269	0.952	3.5	399.4

MTD (mm) M = 3.510 SD = 0.2194 H = 3.842 L = 3.325
MPD (mm) M = 4.134 SD = 0.2742 H = 4.549 L = 3.902
Left Wheel N = 5 M = 33.4 SD = 1.16 H = 34.8 L = 32.1

9.569	16	38.9	0.79	70.1	23.4	39.8	0.06	0.163	0.0374	4.151	0.951	4.01	0.194	0.0368	4.935	0.935	3.5	460.0
9.675	17	36.5	0.96	57.7	19.3	40.2	0.07	0.169	0.0485	4.304	1.232	3.07	0.202	0.0506	5.126	1.286	3.5	477.3
9.752	18	38.9	0.60	60.2	20.1	40.1	0.14	0.187	0.0472	4.744	1.198	4.38	0.223	0.0489	5.676	1.243	3.5	527.3
9.835	19	37.0	0.68	55.4	18.5	40.1	0.06	0.171	0.0432	4.342	1.098	4.34	0.204	0.0441	5.173	1.119	3.5	481.6
9.936	20	37.8	0.83	56.2	18.7	40.4	0.04	0.165	0.0391	4.191	0.993	4.49	0.196	0.0389	4.985	0.988	3.5	464.5

MTD (mm) M = 4.346 SD = 0.2357 H = 4.744 L = 4.151
MPD (mm) M = 5.179 SD = 0.2946 H = 5.676 L = 4.935
Left Wheel N = 5 M = 37.8 SD = 1.12 H = 38.9 L = 36.5

19.774	21	40.9	0.67	72.2	24.1	40.0	0.05	0.049	0.0114	1.237	0.289	0.02	0.051	0.0042	1.293	0.107	3.5	129.0
19.844	22	40.1	0.69	62.8	20.9	40.1	0.04	0.047	0.0124	1.198	0.316	0.01	0.049	0.0055	1.244	0.141	3.5	124.5
19.915	23	42.7	0.93	62.4	20.8	40.0	0.04	0.055	0.0177	1.405	0.450	0.05	0.059	0.0121	1.503	0.308	3.5	148.1
19.983	24	41.6	0.73	62.4	20.8	41.0	0.20	0.052	0.0136	1.329	0.345	0.02	0.055	0.0070	1.408	0.177	3.5	139.4
20.054	25	41.7	0.76	61.1	20.4	40.0	0.09	0.049	0.0132	1.252	0.335	0.01	0.052	0.0065	1.312	0.165	3.5	130.7

MTD (mm) M = 1.285 SD = 0.0826 H = 1.405 L = 1.198
MPD (mm) M = 1.352 SD = 0.1033 H = 1.503 L = 1.244
Left Wheel N = 5 M = 41.4 SD = 0.97 H = 42.7 L = 40.1

ASTM REP 2	DATE 02/18/04		BLANK TIRE		40 MPH														
TEST	REF.	CYCLE	FN				SPEED		MTD				%	MPD				IFI	
SECT.	POST	NUM.	AVG	STD	PEAK	VALLEY	AVG	STD	(in)	STD. (in)	(mm)	STD. (mm)	ERROR	(in)	STD. (in)	(mm)	STD. (mm)	F60	Sp
#1 FC-3	0.029	1	1.6	0.53	0.0	0.0	39.9	0.03	0.043	0.012	1.081	0.300	0.00	0.043	0.005	1.097	0.121	3.5	111.2
	0.140	2	1.6	0.53	0.0	0.0	39.9	0.04	0.043	0.012	1.097	0.298	0.00	0.044	0.005	1.118	0.119	3.5	113.1
	0.233	3	1.5	0.58	0.0	0.0	40.1	0.03	0.046	0.012	1.167	0.311	0.00	0.047	0.005	1.205	0.134	3.5	121.0
	0.314	4	1.6	0.56	0.0	0.0	40.0	0.03	0.049	0.014	1.238	0.354	0.00	0.051	0.007	1.293	0.188	3.5	129.0
	0.454	5	1.5	0.56	0.0	0.0	39.5	0.04	0.050	0.016	1.281	0.405	0.00	0.053	0.010	1.347	0.252	3.5	133.9
	N		5				5		5		5			5		5		5	5
	Mean		**1.6**				**39.9**		**0.046**		**1.173**			**0.048**		**1.212**		**3.5**	**121.6**
	Std.		0.1				0.2		0.003		0.087			0.004		0.108		0.0	9.8
	Hi		1.6				40.1		0.050		1.281			0.053		1.347		3.5	133.9
	Lo		1.5				39.5		0.043		1.081			0.043		1.097		3.5	111.2
#2 FC-2	1.134	6	1.3	0.56	0.0	0.0	40.4	0.04	0.119	0.027	3.010	0.683	1.90	0.138	0.024	3.509	0.600	3.5	330.4
	1.223	7	1.3	0.58	0.0	0.0	40.3	0.04	0.118	0.032	2.998	0.812	1.18	0.138	0.030	3.493	0.762	3.5	329.0
	1.312	8	1.2	0.58	0.0	0.0	40.1	0.04	0.123	0.029	3.134	0.736	1.86	0.144	0.026	3.664	0.666	3.5	344.4
	1.402	9	1.3	0.56	0.0	0.0	39.6	0.03	0.127	0.027	3.220	0.697	1.69	0.148	0.024	3.771	0.617	3.5	354.2
	1.492	10	1.4	0.55	0.0	0.0	39.7	0.04	0.121	0.027	3.084	0.675	1.87	0.142	0.023	3.601	0.589	3.5	338.7
	N		5				5		5		5			5		5		5	5
	Mean		**1.3**				**40.0**		**0.122**		**3.089**			**0.142**		**3.608**		**3.5**	**339.3**
	Std.		0.1				0.4		0.004		0.092			0.004		0.115		0.0	10.4
	Hi		1.4				40.4		0.127		3.220			0.148		3.771		3.5	354.2
	Lo		1.2				39.6		0.118		2.998			0.138		3.493		3.5	329.0
#3 FC-5-OO	6.845	11	1.1	0.56	0.0	0.0	40.0	0.03	0.139	0.042	3.543	1.077	3.15	0.164	0.043	4.174	1.092	3.5	390.8
	6.952	12	1.0	0.56	0.0	0.0	39.8	0.03	0.149	0.045	3.777	1.151	3.51	0.176	0.047	4.467	1.184	3.5	417.5
	7.052	13	1.0	0.54	0.0	0.0	39.9	0.03	0.153	0.034	3.875	0.853	2.86	0.181	0.032	4.590	0.812	3.5	428.6
	7.144	14	1.0	0.55	0.0	0.0	40.0	0.03	0.134	0.032	3.407	0.813	2.76	0.158	0.030	4.004	0.763	3.5	375.4
	7.234	15	0.9	0.55	0.0	0.0	40.1	0.03	0.157	0.036	3.984	0.907	3.67	0.186	0.035	4.726	0.880	3.5	441.0
	N		5				5		5		5			5		5		5	5
	Mean		**1.0**				**40.0**		**0.146**		**3.717**			**0.173**		**4.392**		**3.5**	**410.7**
	Std.		0.1				0.1		0.010		0.238			0.012		0.298		0.0	27.1
	Hi		1.1				40.1		0.157		3.984			0.186		4.726		3.5	441.0
	Lo		0.9				39.8		0.134		3.407			0.158		4.004		3.5	375.4
#4 FC-5-GR	9.562	16	0.8	0.52	0.0	0.0	39.9	0.03	0.179	0.050	4.543	1.261	4.74	0.214	0.052	5.424	1.322	3.5	504.4
	9.669	17	0.8	0.53	0.0	0.0	40.5	0.03	0.173	0.044	4.388	1.104	4.25	0.206	0.044	5.231	1.126	3.5	486.9
	9.745	18	1.1	0.53	0.0	0.0	40.0	0.13	0.184	0.049	4.680	1.244	4.33	0.220	0.051	5.596	1.301	3.5	520.0
	9.829	19	0.9	0.53	0.0	0.0	39.8	0.08	0.174	0.045	4.430	1.140	4.47	0.208	0.046	5.283	1.171	3.5	491.6
	9.928	20	0.8	0.52	0.0	0.0	39.8	0.03	0.168	0.042	4.267	1.070	4.17	0.200	0.043	5.080	1.083	3.5	473.1
	N		5				5		5		5			5		5		5	5
	Mean		**0.9**				**40.0**		**0.176**		**4.462**			**0.210**		**5.323**		**3.5**	**495.2**
	Std.		0.1				0.3		0.006		0.157			0.008		0.196		0.0	17.8
	Hi		1.1				40.5		0.184		4.680			0.220		5.596		3.5	520.0
	Lo		0.8				39.8		0.168		4.267			0.200		5.080		3.5	473.1
#5 FC-4	0.029	1	0.6	0.46	0.0	0.0	40.3	0.05	0.050	0.014	1.276	0.342	0.00	0.053	0.007	1.341	0.174	3.5	133.4
	0.098	2	0.6	0.42	0.0	0.0	40.5	0.03	0.051	0.014	1.284	0.366	0.01	0.053	0.008	1.351	0.203	3.5	134.3
	0.170	3	0.6	0.43	0.0	0.0	40.6	0.04	0.057	0.015	1.455	0.384	0.02	0.062	0.009	1.564	0.226	3.5	153.6
	0.237	4	0.6	0.37	0.0	0.0	40.5	0.05	0.056	0.017	1.425	0.419	0.01	0.060	0.011	1.527	0.269	3.5	150.2
	0.310	5	0.6	0.42	0.0	0.0	39.8	0.05	0.054	0.013	1.381	0.325	0.05	0.058	0.006	1.473	0.152	3.5	145.3
	N		5				5		5		5			5		5		5	5
	Mean		**0.6**				**40.3**		**0.054**		**1.364**			**0.057**		**1.451**		**3.5**	**143.4**
	Std.		0.0				0.3		0.003		0.081			0.004		0.101		0.0	9.2
	Hi		0.6				40.6		0.057		1.455			0.062		1.564		3.5	153.6
	Lo		0.6				39.8		0.050		1.276			0.053		1.341		3.5	133.4

Figure A-II-9 **Summary of Laser Texture Data Collected on 02/18/04, 40 MPH, No Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).**

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\26.K04
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR DIR Asc (+) LANE 1
OPERATOR AMS DRIVER AMS VEHICLE UNIT#7 EQUIPMENT MD4040/S
CO-SEC&LEG 26 FIN_NO. TEST SECTIONS REQ_TYPE 3
DATE 02/18/2004 TIME 14:35:18 **TIRE Smooth**
AIR_TEMPERATURE 60.0øF CONDITIONS DAY/CLEAR

REF CYCLE **FN** FN FN FN **SPEED** SPEED IN IN MM MM % IN IN MM MM
POST NUMBER AVG STD PEAK VALLEY AVG STD MTD MTD Std MTD MTD Std Error MPD MPD Std
MPD MPD Std F60 SP

0.029	1	**1.6**	0.53	0.0	0.0	**39.9**	0.03	0.043	0.0118	1.081	0.300	0.00	0.043	0.0048	1.097	0.121	3.5	111.2
0.140	2	1.6	0.53	0.0	0.0	39.9	0.04	0.043	0.0118	1.097	0.298	0.00	0.044	0.0047	1.118	0.119	3.5	113.1
0.233	3	1.5	0.58	0.0	0.0	40.1	0.03	0.046	0.0122	1.167	0.311	0.00	0.047	0.0053	1.205	0.134	3.5	121.0
0.314	4	1.6	0.56	0.0	0.0	40.0	0.03	0.049	0.0139	1.238	0.354	0.00	0.051	0.0074	1.293	0.188	3.5	129.0
0.454	5	1.5	0.56	0.0	0.0	39.5	0.04	0.050	0.0159	1.281	0.405	0.00	0.053	0.0099	1.347	0.252	3.5	133.9

MTD (mm) M = 1.173 SD = 0.0867 H = 1.281 L = 1.081
MPD (mm) M = 1.212 SD = 0.1084 H = 1.347 L = 1.097
Left Wheel N = 5 M = 1.6 SD = 0.03 H = 1.6 L = 1.5

1.134	6	1.3	0.56	0.0	0.0	40.4	0.04	0.119	0.0269	3.010	0.683	1.90	0.138	0.0236	3.509	0.600	3.5	330.4
1.223	7	1.3	0.58	0.0	0.0	40.3	0.04	0.118	0.0320	2.998	0.812	1.18	0.138	0.0300	3.493	0.762	3.5	329.0
1.312	8	1.2	0.58	0.0	0.0	40.1	0.04	0.123	0.0290	3.134	0.736	1.86	0.144	0.0262	3.664	0.666	3.5	344.4
1.402	9	1.3	0.56	0.0	0.0	39.6	0.03	0.127	0.0274	3.220	0.697	1.69	0.148	0.0243	3.771	0.617	3.5	354.2
1.492	10	1.4	0.55	0.0	0.0	39.7	0.04	0.121	0.0266	3.084	0.675	1.87	0.142	0.0232	3.601	0.589	3.5	338.7

MTD (mm) M = 3.089 SD = 0.0917 H = 3.220 L = 2.998
MPD (mm) M = 3.607 SD = 0.1146 H = 3.771 L = 3.493
Left Wheel N = 5 M = 1.3 SD = 0.06 H = 1.4 L = 1.2

6.845	11	1.1	0.56	0.0	0.0	40.0	0.03	0.139	0.0424	3.543	1.077	3.15	0.164	0.0430	4.174	1.092	3.5	390.8
6.952	12	1.0	0.56	0.0	0.0	39.8	0.03	0.149	0.0453	3.777	1.151	3.51	0.176	0.0466	4.467	1.184	3.5	417.5
7.052	13	1.0	0.54	0.0	0.0	39.9	0.03	0.153	0.0336	3.875	0.853	2.86	0.181	0.0320	4.590	0.812	3.5	428.6
7.144	14	1.0	0.55	0.0	0.0	40.0	0.03	0.134	0.0320	3.407	0.813	2.76	0.158	0.0300	4.004	0.763	3.5	375.4
7.234	15	0.9	0.55	0.0	0.0	40.1	0.03	0.157	0.0357	3.984	0.907	3.67	0.186	0.0347	4.726	0.880	3.5	441.0

MTD (mm) M = 3.717 SD = 0.2380 H = 3.984 L = 3.407
MPD (mm) M = 4.392 SD = 0.2975 H = 4.726 L = 4.004
Left Wheel N = 5 M = 1.0 SD = 0.06 H = 1.1 L = 0.9

9.562	16	0.8	0.52	0.0	0.0	39.9	0.03	0.179	0.0496	4.543	1.261	4.74	0.214	0.0520	5.424	1.322	3.5	504.4
9.669	17	0.8	0.53	0.0	0.0	40.5	0.03	0.173	0.0435	4.388	1.104	4.25	0.206	0.0443	5.231	1.126	3.5	486.9
9.745	18	1.1	0.53	0.0	0.0	40.0	0.13	0.184	0.0490	4.680	1.244	4.33	0.220	0.0512	5.596	1.301	3.5	520.0
9.829	19	0.9	0.53	0.0	0.0	39.8	0.08	0.174	0.0449	4.430	1.140	4.47	0.208	0.0461	5.283	1.171	3.5	491.6
9.928	20	0.8	0.52	0.0	0.0	39.8	0.03	0.168	0.0421	4.267	1.070	4.17	0.200	0.0427	5.080	1.083	3.5	473.1

MTD (mm) M = 4.461 SD = 0.1570 H = 4.680 L = 4.267
MPD (mm) M = 5.323 SD = 0.1962 H = 5.596 L = 5.080
Left Wheel N = 5 M = 0.9 SD = 0.13 H = 1.1 L = 0.8

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\26.K05
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR DIR Asc (+) LANE 1
OPERATOR AMS DRIVER AMS VEHICLE UNIT#7 EQUIPMENT MD4040/S
CO-SEC&LEG 26 FIN_NO. TEST SECTIONS REQ_TYPE 3
DATE 02/18/2004 TIME 14:49:44 **TIRE Smooth**
AIR_TEMPERATURE 60.0øF CONDITIONS DAY/CLEAR

REF CYCLE **FN** FN FN FN **SPEED** SPEED IN IN MM MM % IN IN MM MM
POST NUMBER AVG STD PEAK VALLEY AVG STD MTD MTD Std MTD MTD Std Error MPD MPD Std
MPD MPD Std F60 SP

0.029	1	**0.6**	0.46	0.0	0.0	**40.3**	0.05	0.050	0.0135	1.276	0.342	0.00	0.053	0.0068	1.341	0.174	3.5	133.4
0.098	2	0.6	0.42	0.0	0.0	40.5	0.03	0.051	0.0144	1.284	0.366	0.01	0.053	0.0080	1.351	0.203	3.5	134.3
0.170	3	0.6	0.43	0.0	0.0	40.6	0.04	0.057	0.0151	1.455	0.384	0.02	0.062	0.0089	1.564	0.226	3.5	153.6
0.237	4	0.6	0.37	0.0	0.0	40.5	0.05	0.056	0.0165	1.425	0.419	0.01	0.060	0.0106	1.527	0.269	3.5	150.2
0.310	5	0.6	0.42	0.0	0.0	39.8	0.05	0.054	0.0128	1.381	0.325	0.05	0.058	0.0060	1.473	0.152	3.5	145.3

MTD (mm) M = 1.364 SD = 0.0811 H = 1.455 L = 1.276
MPD (mm) M = 1.451 SD = 0.1013 H = 1.564 L = 1.341
Left Wheel N = 5 M = 0.6 SD = 0.02 H = 0.6 L = 0.6

ASTM REP 1	DATE 03/23/04		RIB TIRE		20 MPH														
TEST	REF.	CYCLE	FN				SPEED		MTD				%	MPD				IFI	
SECT.	POST	NUM.	AVG	STD	PEAK	VALLEY	AVG	STD	(in)	STD. (in)	(mm)	STD. (mm)	ERROR	(in)	STD. (in)	(mm)	STD. (mm)	F60	Sp
#1 FC-3	0.006	1	2.1	0.13	0.0	0.0	20.3	0.13	0.040	0.012	1.022	0.310	0.04	0.040	0.005	1.023	0.134	0.1	104.5
	0.116	2	2.0	0.15	0.0	0.0	20.2	0.03	0.041	0.013	1.037	0.324	0.00	0.041	0.006	1.043	0.151	0.3	106.2
	0.210	3	1.9	0.12	0.0	0.0	19.8	0.04	0.040	0.011	1.005	0.280	0.00	0.039	0.004	1.002	0.096	0.0	102.6
	0.291	4	1.9	0.14	0.0	0.0	20.2	0.03	0.043	0.012	1.104	0.304	0.00	0.044	0.005	1.126	0.125	1.0	113.8
	0.431	5	2.0	0.16	0.0	0.0	19.6	0.86	0.049	0.016	1.251	0.414	0.01	0.052	0.010	1.310	0.263	2.5	130.5
	N		5				5		5		5			5		5		5	5
	Mean		**2.0**				**20.0**		**0.043**		**1.084**			**0.043**		**1.101**		**0.8**	**111.5**
	Std.		0.1				0.3		0.004		0.101			0.005		0.126		1.0	11.4
	Hi		2.1				20.3		0.049		1.251			0.052		1.310		2.5	130.5
	Lo		1.9				19.6		0.040		1.005			0.039		1.002		0.0	102.6
#2 FC-2	1.113	6	1.7	0.15	0.0	0.0	18.8	0.61	0.117	0.029	2.982	0.739	1.11	0.137	0.026	3.473	0.670	20.7	327.1
	1.200	7	1.8	0.13	0.0	0.0	19.6	0.82	0.109	0.032	2.765	0.822	1.13	0.126	0.031	3.202	0.774	18.4	302.5
	1.290	8	1.7	0.17	0.0	0.0	19.5	1.22	0.120	0.024	3.039	0.613	1.81	0.140	0.020	3.544	0.512	21.3	333.6
	1.382	9	1.7	0.15	0.0	0.0	19.3	1.39	0.130	0.026	3.291	0.655	1.58	0.152	0.022	3.859	0.565	24.0	362.2
	1.473	10	1.7	0.20	0.0	0.0	20.0	1.35	0.118	0.029	3.010	0.723	1.49	0.138	0.026	3.508	0.650	21.0	330.3
	N		5				5		5		5			5		5		5	5
	Mean		**1.7**				**19.4**		**0.119**		**3.017**			**0.139**		**3.517**		**21.1**	**331.1**
	Std.		0.0				0.4		0.008		0.187			0.009		0.234		2.0	21.3
	Hi		1.8				20.0		0.130		3.291			0.152		3.859		24.0	362.2
	Lo		1.7				18.8		0.109		2.765			0.126		3.202		18.4	302.5
#3 FC-5-OO	6.839	11	1.4	0.16	0.0	0.0	20.8	0.75	0.138	0.037	3.493	0.935	2.39	0.162	0.036	4.112	0.914	26.1	385.2
	6.946	12	1.5	0.15	0.0	0.0	19.8	1.13	0.157	0.039	3.993	0.983	3.19	0.187	0.038	4.737	0.975	31.3	442.0
	7.046	13	1.4	0.14	0.0	0.0	19.6	1.02	0.141	0.038	3.589	0.962	2.52	0.167	0.037	4.233	0.949	27.1	396.1
	7.140	14	1.4	0.14	0.0	0.0	20.4	0.54	0.139	0.041	3.532	1.031	2.42	0.164	0.041	4.161	1.035	26.5	389.6
	7.230	15	1.3	0.13	0.0	0.0	19.0	1.58	0.133	0.036	3.389	0.909	2.35	0.157	0.035	3.982	0.883	25.0	373.4
	N		5				5		5		5			5		5		5	5
	Mean		**1.4**				**19.9**		**0.142**		**3.599**			**0.167**		**4.245**		**27.2**	**397.3**
	Std.		0.1				0.7		0.009		0.232			0.012		0.290		2.4	26.3
	Hi		1.5				20.8		0.157		3.993			0.187		4.737		31.3	442.0
	Lo		1.3				19.0		0.133		3.389			0.157		3.982		25.0	373.4
#4 FC-5-GR	9.562	16	1.2	0.14	0.0	0.0	19.6	0.73	0.183	0.049	4.657	1.232	4.36	0.219	0.051	5.567	1.286	38.3	517.4
	9.669	17	1.1	0.16	0.0	0.0	19.9	0.88	0.196	0.056	4.977	1.410	3.14	0.235	0.059	5.967	1.508	41.7	553.8
	10.683	18	1.0	0.15	0.0	0.0	20.0	0.80	0.190	0.040	4.817	1.024	3.81	0.227	0.040	5.767	1.026	40.0	535.6
	10.769	19	1.0	0.14	0.0	0.0	18.9	1.25	0.195	0.050	4.953	1.270	3.28	0.234	0.053	5.937	1.334	41.4	551.0
	10.871	20	1.1	0.14	0.0	0.0	19.7	0.95	0.172	0.041	4.372	1.049	4.00	0.205	0.042	5.211	1.057	35.3	485.1
	N		5				5		5		5			5		5		5	5
	Mean		**1.1**				**19.6**		**0.187**		**4.755**			**0.224**		**5.690**		**39.3**	**528.6**
	Std.		0.1				0.4		0.010		0.249			0.012		0.312		2.6	28.3
	Hi		1.2				20.0		0.196		4.977			0.235		5.967		41.7	553.8
	Lo		1.0				18.9		0.172		4.372			0.205		5.211		35.3	485.1
#5 FC-4	23.024	21	0.3	0.15	0.0	0.0	20.9	0.21	0.052	0.015	1.313	0.370	0.01	0.055	0.008	1.388	0.208	3.2	137.6
	23.094	22	0.3	0.13	0.0	0.0	20.4	0.53	0.051	0.013	1.292	0.318	0.01	0.054	0.006	1.361	0.144	3.0	135.2
	23.165	23	0.3	0.16	0.0	0.0	19.6	0.99	0.054	0.014	1.372	0.347	0.02	0.058	0.007	1.461	0.179	3.8	144.3
	23.233	24	0.2	0.13	0.0	0.0	20.9	0.17	0.054	0.014	1.378	0.363	0.00	0.058	0.008	1.468	0.200	3.9	144.9
	23.306	25	0.2	0.12	0.0	0.0	20.2	0.21	0.054	0.014	1.373	0.362	0.00	0.058	0.008	1.462	0.198	3.8	144.3
	N		5				5		5		5			5		5		5	5
	Mean		**0.3**				**20.4**		**0.053**		**1.346**			**0.057**		**1.428**		**3.5**	**141.3**
	Std.		0.1				0.5		0.001		0.040			0.002		0.050		0.4	4.5
	Hi		0.3				20.9		0.054		1.378			0.058		1.468		3.9	144.9
	Lo		0.2				19.6		0.051		1.292			0.054		1.361		3.0	135.2

Figure A-II-10 **Summary of Laser Texture Data Collected on 03/23/04, 20 MPH, No Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).**

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\LASER04.K01
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR DIR Asc (+) LANE 0
OPERATOR AMS DRIVER AMS VEHICLE UNIT#7 EQUIPMENT MD4040/R
CO-SEC&LEG LASER04 FIN_NO. REQ_TYPE 3
DATE 03/23/2004 TIME 09:01:53 **TIRE Rib**
AIR_TEMPERATURE 58.0øF CONDITIONS DAY/CLEAR

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
0.006	1	**2.1**	0.13	0.0	0.0	**20.3**	0.13	0.040	0.0122	1.022	0.310	0.04	0.040	0.0053	1.023	0.134	0.1	104.5
0.116	2	2.0	0.15	0.0	0.0	20.2	0.03	0.041	0.0128	1.037	0.324	0.00	0.041	0.0060	1.043	0.151	0.3	106.2
0.210	3	1.9	0.12	0.0	0.0	19.8	0.04	0.040	0.0110	1.005	0.280	0.00	0.039	0.0038	1.002	0.096	0.0	102.6
0.291	4	1.9	0.14	0.0	0.0	20.2	0.03	0.043	0.0119	1.104	0.304	0.00	0.044	0.0049	1.126	0.125	1.0	113.8
0.431	5	2.0	0.16	0.0	0.0	19.6	0.86	0.049	0.0163	1.251	0.414	0.01	0.052	0.0104	1.310	0.263	2.5	130.5

MTD (mm) M = 1.084 SD = 0.1007 H = 1.251 L = 1.005
MPD (mm) M = 1.101 SD = 0.1259 H = 1.310 L = 1.002
Left Wheel N = 5 M = 2.0 SD = 0.05 H = 2.1 L = 1.9

1.113	6	1.7	0.15	0.0	0.0	18.8	0.61	0.117	0.0291	2.982	0.739	1.11	0.137	0.0264	3.473	0.670	20.7	327.1
1.200	7	1.8	0.13	0.0	0.0	19.6	0.82	0.109	0.0324	2.765	0.822	1.13	0.126	0.0305	3.202	0.774	18.4	302.5
1.290	8	1.7	0.17	0.0	0.0	19.5	1.22	0.120	0.0241	3.039	0.613	1.81	0.140	0.0202	3.544	0.512	21.3	333.6
1.382	9	1.7	0.15	0.0	0.0	19.3	1.39	0.130	0.0258	3.291	0.655	1.58	0.152	0.0222	3.859	0.565	24.0	362.2
1.473	10	1.7	0.20	0.0	0.0	20.0	1.35	0.118	0.0285	3.010	0.723	1.49	0.138	0.0256	3.508	0.650	21.0	330.3

MTD (mm) M = 3.017 SD = 0.1874 H = 3.291 L = 2.765
MPD (mm) M = 3.517 SD = 0.2342 H = 3.859 L = 3.202
Left Wheel N = 5 M = 1.7 SD = 0.03 H = 1.8 L = 1.7

6.839	11	1.4	0.16	0.0	0.0	20.8	0.75	0.138	0.0368	3.493	0.935	2.39	0.162	0.0360	4.112	0.914	26.1	385.2
6.946	12	1.5	0.15	0.0	0.0	19.8	1.13	0.157	0.0387	3.993	0.983	3.19	0.187	0.0384	4.737	0.975	31.3	442.0
7.046	13	1.4	0.14	0.0	0.0	19.6	1.02	0.141	0.0379	3.589	0.962	2.52	0.167	0.0373	4.233	0.949	27.1	396.1
7.140	14	1.4	0.14	0.0	0.0	20.4	0.54	0.139	0.0406	3.532	1.031	2.42	0.164	0.0408	4.161	1.035	26.5	389.6
7.230	15	1.3	0.13	0.0	0.0	19.0	1.58	0.133	0.0358	3.389	0.909	2.35	0.157	0.0348	3.982	0.883	25.0	373.4

MTD (mm) M = 3.599 SD = 0.2320 H = 3.993 L = 3.389
MPD (mm) M = 4.245 SD = 0.2900 H = 4.737 L = 3.982
Left Wheel N = 5 M = 1.4 SD = 0.05 H = 1.5 L = 1.3

9.562	16	1.2	0.14	0.0	0.0	19.6	0.73	0.183	0.0485	4.657	1.232	4.36	0.219	0.0506	5.567	1.286	38.3	517.4
9.669	17	1.1	0.16	0.0	0.0	19.9	0.88	0.196	0.0555	4.977	1.410	3.14	0.235	0.0594	5.967	1.508	41.7	553.8
10.683	18	1.0	0.15	0.0	0.0	20.0	0.80	0.190	0.0403	4.817	1.024	3.81	0.227	0.0404	5.767	1.026	40.0	535.6
10.769	19	1.0	0.14	0.0	0.0	18.9	1.25	0.195	0.0500	4.953	1.270	3.28	0.234	0.0525	5.937	1.334	41.4	551.0
10.871	20	1.1	0.14	0.0	0.0	19.7	0.95	0.172	0.0413	4.372	1.049	4.00	0.205	0.0416	5.211	1.057	35.3	485.1

MTD (mm) M = 4.755 SD = 0.2492 H = 4.977 L = 4.372
MPD (mm) M = 5.690 SD = 0.3115 H = 5.967 L = 5.211
Left Wheel N = 5 M = 1.1 SD = 0.07 H = 1.2 L = 1.0

23.024	21	0.3	0.15	0.0	0.0	20.9	0.21	0.052	0.0146	1.313	0.370	0.01	0.055	0.0082	1.388	0.208	3.2	137.6
23.094	22	0.3	0.13	0.0	0.0	20.4	0.53	0.051	0.0125	1.292	0.318	0.01	0.054	0.0057	1.361	0.144	3.0	135.2
23.165	23	0.3	0.16	0.0	0.0	19.6	0.99	0.054	0.0136	1.372	0.347	0.02	0.058	0.0071	1.461	0.179	3.8	144.3
23.233	24	0.2	0.13	0.0	0.0	20.9	0.17	0.054	0.0143	1.378	0.363	0.00	0.058	0.0079	1.468	0.200	3.9	144.9
23.306	25	0.2	0.12	0.0	0.0	20.2	0.21	0.054	0.0142	1.373	0.362	0.00	0.058	0.0078	1.462	0.198	3.8	144.3

MTD (mm) M = 1.346 SD = 0.0398 H = 1.378 L = 1.292
MPD (mm) M = 1.428 SD = 0.0497 H = 1.468 L = 1.361
Left Wheel N = 5 M = 0.3 SD = 0.06 H = 0.3 L = 0.2

ASTM REP 2	DATE 03/23/04		RIB TIRE		20 MPH														
TEST	REF.	CYCLE	FN				SPEED		MTD				%	MPD				IFI	
SECT.	POST	NUM.	AVG	STD	PEAK	VALLEY	AVG	STD	(in)	STD. (in)	(mm)	STD. (mm)	ERROR	(in)	STD. (in)	(mm)	STD. (mm)	F60	Sp
#1 FC-3	0.006	1	0.3	0.13	0.0	0.0	18.8	1.37	0.040	0.011	1.006	0.285	0.00	0.040	0.004	1.004	0.102	0.0	102.7
	0.115	2	0.2	0.12	0.0	0.0	18.9	1.06	0.038	0.011	0.977	0.270	0.00	0.038	0.003	0.968	0.084	0.0	99.4
	0.209	3	0.2	0.12	0.0	0.0	19.9	0.61	0.039	0.012	0.992	0.303	0.00	0.039	0.005	0.986	0.125	0.0	101.1
	0.291	4	0.2	0.11	0.0	0.0	19.2	1.14	0.043	0.013	1.094	0.323	0.00	0.044	0.006	1.113	0.150	0.9	112.6
	0.431	5	0.2	0.12	0.0	0.0	18.6	0.93	0.045	0.012	1.137	0.310	0.00	0.046	0.005	1.167	0.134	1.3	117.5
	N		5				5		5		5			5		5		5	5
	Mean		**0.2**				**19.1**		**0.041**		**1.041**			**0.041**		**1.048**		**0.4**	**106.7**
	Std.		0.0				0.5		0.003		0.070			0.003		0.087		0.6	7.9
	Hi		0.3				19.9		0.045		1.137			0.046		1.167		1.3	117.5
	Lo		0.2				18.6		0.038		0.977			0.038		0.968		0.0	99.4
#2 FC-2	1.110	6	0.3	0.14	0.0	0.0	19.5	0.78	0.124	0.031	3.141	0.784	1.10	0.145	0.029	3.672	0.726	22.4	345.2
	1.201	7	0.1	0.07	0.0	0.0	20.3	0.14	0.110	0.024	2.788	0.602	0.75	0.127	0.020	3.231	0.498	18.7	305.1
	1.289	8	0.2	0.13	0.0	0.0	19.2	0.14	0.124	0.030	3.142	0.753	1.31	0.145	0.027	3.674	0.688	22.4	345.4
	1.380	9	0.2	0.13	0.0	0.0	20.3	0.17	0.130	0.027	3.305	0.689	1.56	0.153	0.024	3.878	0.607	24.1	363.9
	1.471	10	0.2	0.14	0.0	0.0	18.1	1.37	0.128	0.032	3.251	0.810	1.40	0.150	0.030	3.810	0.758	23.5	357.7
	N		5				5		5		5			5		5		5	5
	Mean		**0.2**				**19.5**		**0.123**		**3.125**			**0.144**		**3.653**		**22.2**	**343.5**
	Std.		0.1				0.9		0.008		0.201			0.010		0.252		2.1	22.9
	Hi		0.3				20.3		0.130		3.305			0.153		3.878		24.1	363.9
	Lo		0.1				18.1		0.110		2.788			0.127		3.231		18.7	305.1
#3 FC-5-OO	6.837	11	0.3	0.14	0.0	0.0	20.9	0.04	0.138	0.037	3.507	0.947	2.53	0.163	0.037	4.130	0.929	26.2	386.8
	6.944	12	0.4	0.13	0.0	0.0	19.9	0.08	0.149	0.046	3.774	1.162	2.63	0.176	0.047	4.463	1.198	29.0	417.1
	7.043	13	0.3	0.12	0.0	0.0	19.8	0.09	0.128	0.035	3.240	0.879	2.21	0.149	0.033	3.796	0.845	23.4	356.5
	7.135	14	0.3	0.12	0.0	0.0	19.8	0.05	0.143	0.037	3.626	0.936	2.57	0.168	0.036	4.278	0.916	27.5	400.3
	7.230	15	0.3	0.13	0.0	0.0	20.0	0.08	0.141	0.041	3.574	1.043	2.47	0.166	0.041	4.214	1.050	26.9	394.4
	N		5				5		5		5			5		5		5	5
	Mean		**0.3**				**20.1**		**0.140**		**3.544**			**0.164**		**4.176**		**26.6**	**391.0**
	Std.		0.0				0.5		0.008		0.196			0.010		0.245		2.1	22.3
	Hi		0.4				20.9		0.149		3.774			0.176		4.463		29.0	417.1
	Lo		0.3				19.8		0.128		3.240			0.149		3.796		23.4	356.5
#4 FC-5-GR	9.560	16	0.4	0.13	0.0	0.0	20.1	0.09	0.182	0.048	4.612	1.207	3.65	0.217	0.049	5.511	1.255	37.8	512.3
	9.667	17	0.3	0.13	0.0	0.0	20.1	0.04	0.174	0.047	4.417	1.189	3.57	0.207	0.049	5.268	1.232	35.8	490.2
	9.741	18	0.4	0.14	0.0	0.0	20.4	0.11	0.179	0.046	4.553	1.156	3.72	0.214	0.047	5.437	1.191	37.2	505.6
	9.825	19	0.4	0.13	0.0	0.0	20.3	0.11	0.171	0.042	4.349	1.077	4.04	0.204	0.043	5.182	1.092	35.1	482.4
	9.928	20	0.3	0.14	0.0	0.0	20.2	0.06	0.170	0.039	4.325	0.994	4.66	0.203	0.039	5.152	0.988	34.8	479.7
	N		5				5		5		5			5		5		5	5
	Mean		**0.4**				**20.2**		**0.175**		**4.451**			**0.209**		**5.310**		**36.1**	**494.0**
	Std.		0.1				0.1		0.005		0.126			0.006		0.158		1.3	14.3
	Hi		0.4				20.4		0.182		4.612			0.217		5.511		37.8	512.3
	Lo		0.3				20.1		0.170		4.325			0.203		5.152		34.8	479.7
#5 FC-4	19.764	21	0.2	0.12	0.0	0.0	19.8	0.05	0.050	0.013	1.274	0.340	0.03	0.053	0.007	1.338	0.171	2.8	133.1
	19.834	22	0.2	0.11	0.0	0.0	19.7	0.03	0.051	0.015	1.305	0.377	0.00	0.054	0.009	1.378	0.217	3.1	136.7
	19.907	23	0.3	0.15	0.0	0.0	20.1	0.21	0.054	0.014	1.359	0.364	0.02	0.057	0.008	1.445	0.200	3.7	142.8
	19.974	24	0.1	0.09	0.0	0.0	20.4	0.10	0.052	0.013	1.331	0.337	0.00	0.056	0.007	1.410	0.167	3.4	139.7
	20.046	25	0.3	0.15	0.0	0.0	19.7	0.13	0.052	0.012	1.323	0.316	0.00	0.055	0.006	1.400	0.141	3.3	138.7
	N		5				5		5		5			5		5		5	5
	Mean		**0.2**				**19.9**		**0.052**		**1.318**			**0.055**		**1.394**		**3.3**	**138.2**
	Std.		0.1				0.3		0.001		0.032			0.002		0.040		0.3	3.6
	Hi		0.3				20.4		0.054		1.359			0.057		1.445		3.7	142.8
	Lo		0.1				19.7		0.050		1.274			0.053		1.338		2.8	133.1

Figure A-II-11 Summary of Laser Texture Data Collected on 03/23/04, 20 MPH, No Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\LASER04.K02
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR DIR Asc (+) LANE 0
OPERATOR AMS DRIVER AMS VEHICLE UNIT#7 EQUIPMENT MD4040/R
CO-SEC&LEG LASER04 FIN_NO. REQ_TYPE 3
DATE 03/23/2004 TIME 09:40:56 **TIRE Rib**
AIR_TEMPERATURE 58.0øF CONDITIONS DAY/CLEAR

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
0.006	1	**0.3**	0.13	0.0	0.0	**18.8**	1.37	0.040	0.0112	1.006	0.285	0.00	0.040	0.0040	1.004	0.102	0.0	102.7
0.115	2	0.2	0.12	0.0	0.0	18.9	1.06	0.038	0.0106	0.977	0.270	0.00	0.038	0.0033	0.968	0.084	0.0	99.4
0.209	3	0.2	0.12	0.0	0.0	19.9	0.61	0.039	0.0119	0.992	0.303	0.00	0.039	0.0049	0.986	0.125	0.0	101.1
0.291	4	0.2	0.11	0.0	0.0	19.2	1.14	0.043	0.0127	1.094	0.323	0.00	0.044	0.0059	1.113	0.150	0.9	112.6
0.431	5	0.2	0.12	0.0	0.0	18.6	0.93	0.045	0.0122	1.137	0.310	0.00	0.046	0.0053	1.167	0.134	1.3	117.5

MTD (mm) M = 1.041 SD = 0.0701 H = 1.137 L = 0.977
MPD (mm) M = 1.047 SD = 0.0876 H = 1.167 L = 0.968
Left Wheel N = 5 M = 0.2 SD = 0.04 H = 0.3 L = 0.2

1.110	6	0.3	0.14	0.0	0.0	19.5	0.78	0.124	0.0309	3.141	0.784	1.10	0.145	0.0286	3.672	0.726	22.4	345.2
1.201	7	0.1	0.07	0.0	0.0	20.3	0.14	0.110	0.0237	2.788	0.602	0.75	0.127	0.0196	3.231	0.498	18.7	305.1
1.289	8	0.2	0.13	0.0	0.0	19.2	0.14	0.124	0.0297	3.142	0.753	1.31	0.145	0.0271	3.674	0.688	22.4	345.4
1.380	9	0.2	0.13	0.0	0.0	20.3	0.17	0.130	0.0271	3.305	0.689	1.56	0.153	0.0239	3.878	0.607	24.1	363.9
1.471	10	0.2	0.14	0.0	0.0	18.1	1.37	0.128	0.0319	3.251	0.810	1.40	0.150	0.0298	3.810	0.758	23.5	357.7

MTD (mm) M = 3.125 SD = 0.2016 H = 3.305 L = 2.788
MPD (mm) M = 3.653 SD = 0.2520 H = 3.878 L = 3.231
Left Wheel N = 5 M = 0.2 SD = 0.07 H = 0.3 L = 0.1

6.837	11	0.3	0.14	0.0	0.0	20.9	0.04	0.138	0.0373	3.507	0.947	2.53	0.163	0.0366	4.130	0.929	26.2	386.8
6.944	12	0.4	0.13	0.0	0.0	19.9	0.08	0.149	0.0457	3.774	1.162	2.63	0.176	0.0472	4.463	1.198	29.0	417.1
7.043	13	0.3	0.12	0.0	0.0	19.8	0.09	0.128	0.0346	3.240	0.879	2.21	0.149	0.0333	3.796	0.845	23.4	356.5
7.135	14	0.3	0.12	0.0	0.0	19.8	0.05	0.143	0.0368	3.626	0.936	2.57	0.168	0.0361	4.278	0.916	27.5	400.3
7.230	15	0.3	0.13	0.0	0.0	20.0	0.08	0.141	0.0411	3.574	1.043	2.47	0.166	0.0413	4.214	1.050	26.9	394.4

MTD (mm) M = 3.544 SD = 0.1962 H = 3.774 L = 3.240
MPD (mm) M = 4.176 SD = 0.2453 H = 4.463 L = 3.796
Left Wheel N = 5 M = 0.3 SD = 0.02 H = 0.4 L = 0.3

9.560	16	0.4	0.13	0.0	0.0	20.1	0.09	0.182	0.0475	4.612	1.207	3.65	0.217	0.0494	5.511	1.255	37.8	512.3
9.667	17	0.3	0.13	0.0	0.0	20.1	0.04	0.174	0.0468	4.417	1.189	3.57	0.207	0.0485	5.268	1.232	35.8	490.2
9.741	18	0.4	0.14	0.0	0.0	20.4	0.11	0.179	0.0455	4.553	1.156	3.72	0.214	0.0469	5.437	1.191	37.2	505.6
9.825	19	0.4	0.13	0.0	0.0	20.3	0.11	0.171	0.0424	4.349	1.077	4.04	0.204	0.0430	5.182	1.092	35.1	482.4
9.928	20	0.3	0.14	0.0	0.0	20.2	0.06	0.170	0.0391	4.325	0.994	4.66	0.203	0.0389	5.152	0.988	34.8	479.7

MTD (mm) M = 4.451 SD = 0.1263 H = 4.612 L = 4.325
MPD (mm) M = 5.310 SD = 0.1578 H = 5.511 L = 5.152
Left Wheel N = 5 M = 0.3 SD = 0.03 H = 0.4 L = 0.3

19.764	21	0.2	0.12	0.0	0.0	19.8	0.05	0.050	0.0134	1.274	0.340	0.03	0.053	0.0067	1.338	0.171	2.8	133.1
19.834	22	0.2	0.11	0.0	0.0	19.7	0.03	0.051	0.0148	1.305	0.377	0.00	0.054	0.0085	1.378	0.217	3.1	136.7
19.907	23	0.3	0.15	0.0	0.0	20.1	0.21	0.054	0.0143	1.359	0.364	0.02	0.057	0.0079	1.445	0.200	3.7	142.8
19.974	24	0.1	0.09	0.0	0.0	20.4	0.10	0.052	0.0133	1.331	0.337	0.00	0.056	0.0066	1.410	0.167	3.4	139.7
20.046	25	0.3	0.15	0.0	0.0	19.7	0.13	0.052	0.0124	1.323	0.316	0.00	0.055	0.0055	1.400	0.141	3.3	138.7

MTD (mm) M = 1.319 SD = 0.0316 H = 1.359 L = 1.274
MPD (mm) M = 1.394 SD = 0.0396 H = 1.445 L = 1.338
Left Wheel N = 5 M = 0.2 SD = 0.07 H = 0.3 L = 0.1

ASTM REP 1	DATE 03/23/04		RIB TIRE		60 MPH														
TEST SECT.	REF. POST	CYCLE NUM.	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	MTD (in)	MTD STD. (in)	MTD (mm)	MTD STD. (mm)	% ERROR	MPD (in)	MPD STD. (in)	MPD (mm)	MPD STD. (mm)	IFI F60	IFI Sp
#1 FC-3																			
	N		0				0		0		0			0		0		0	0
	Mean		n/a				n/a		n/a		n/a			n/a		n/a		n/a	n/a
	Std.		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
	Hi		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
	Lo		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
#2 FC-2	0.019	1	1.0	0.54	0.0	0.0	60.6	0.35	0.120	0.027	3.041	0.679	2.06	0.140	0.023	3.547	0.595	21.3	333.9
	0.199	2	0.9	0.55	0.0	0.0	60.1	0.24	0.123	0.029	3.136	0.745	1.55	0.144	0.027	3.666	0.677	22.3	344.6
	0.379	3	0.9	0.57	0.0	0.0	59.4	0.18	0.121	0.032	3.075	0.804	1.65	0.141	0.030	3.590	0.752	21.7	337.7
	N		3				3		3		3			3		3		3	3
	Mean		**0.9**				**60.0**		**0.121**		**3.084**			**0.142**		**3.601**		**21.8**	**338.7**
	Std.		0.1				0.6		0.002		0.048			0.002		0.060		0.5	5.4
	Hi		1.0				60.6		0.123		3.136			0.144		3.666		22.3	344.6
	Lo		0.9				59.4		0.120		3.041			0.140		3.547		21.3	333.9
#3 FC-5-OO	5.745	4	0.9	0.54	0.0	0.0	59.9	0.06	0.146	0.042	3.701	1.061	3.71	0.172	0.042	4.372	1.073	28.3	408.8
	5.952	5	1.0	0.58	0.0	0.0	60.0	0.04	0.139	0.033	3.540	0.842	3.26	0.164	0.031	4.170	0.798	26.6	390.5
	6.135	6	0.9	0.56	0.0	0.0	59.8	0.06	0.145	0.034	3.695	0.850	4.31	0.172	0.032	4.364	0.808	28.2	408.1
	N		3				3		3		3			3		3		3	3
	Mean		**0.9**				**59.9**		**0.143**		**3.645**			**0.169**		**4.302**		**27.7**	**402.5**
	Std.		0.1				0.1		0.004		0.091			0.005		0.114		1.0	10.4
	Hi		1.0				60.0		0.146		3.701			0.172		4.372		28.3	408.8
	Lo		0.9				59.8		0.139		3.540			0.164		4.170		26.6	390.5
#4 FC-5-GR	8.467	7	0.9	0.47	0.0	0.0	59.9	0.10	0.171	0.050	4.353	1.272	4.85	0.204	0.053	5.187	1.336	35.1	482.9
	8.651	8	0.9	0.45	0.0	0.0	59.5	0.06	0.168	0.042	4.266	1.067	4.82	0.200	0.043	5.079	1.079	34.2	473.0
	8.835	9	0.8	0.45	0.0	0.0	59.6	0.07	0.179	0.046	4.541	1.162	4.26	0.213	0.047	5.422	1.199	37.1	504.2
	N		3				3		3		3			3		3		3	3
	Mean		**0.9**				**59.7**		**0.173**		**4.387**			**0.206**		**5.229**		**35.5**	**486.7**
	Std.		0.1				0.2		0.006		0.141			0.007		0.175		1.5	15.9
	Hi		0.9				59.9		0.179		4.541			0.213		5.422		37.1	504.2
	Lo		0.8				59.5		0.168		4.266			0.200		5.079		34.2	473.0
#5 FC-4																			
	N		0				0		0		0			0		0		0	0
	Mean		n/a				n/a		n/a		n/a			n/a		n/a		n/a	n/a
	Std.		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
	Hi		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
	Lo		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0

Figure A-II-12 Summary of Laser Texture Data Collected on 03/23/04, 60 MPH, No Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\LASER04.K04
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR DIR Asc (+) LANE 0
OPERATOR AMS DRIVER AMS VEHICLE UNIT#7 EQUIPMENT MD4040/R
CO-SEC&LEG LASER04 FIN_NO. REQ_TYPE 3
DATE 03/23/2004 TIME 10:23:15 **TIRE Rib**
AIR_TEMPERATURE 58.0øF CONDITIONS DAY/CLEAR

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
0.019	1	**1.0**	0.54	0.0	0.0	**60.6**	0.35	0.120	0.0267	3.041	0.679	2.06	0.140	0.0234	3.547	0.595	21.3	333.9
0.199	2	0.9	0.55	0.0	0.0	60.1	0.24	0.123	0.0293	3.136	0.745	1.55	0.144	0.0266	3.666	0.677	22.3	344.6
0.379	3	0.9	0.57	0.0	0.0	59.4	0.18	0.121	0.0317	3.075	0.804	1.65	0.141	0.0296	3.590	0.752	21.7	337.7

MTD (mm) M = 3.084 SD = 0.0481 H = 3.136 L = 3.041
MPD (mm) M = 3.601 SD = 0.0602 H = 3.666 L = 3.547
Left Wheel N = 3 M = 1.0 SD = 0.06 H = 1.0 L = 0.9

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
5.745	4	0.9	0.54	0.0	0.0	59.9	0.06	0.146	0.0418	3.701	1.061	3.71	0.172	0.0422	4.372	1.073	28.3	408.8
5.952	5	1.0	0.58	0.0	0.0	60.0	0.04	0.139	0.0331	3.540	0.842	3.26	0.164	0.0314	4.170	0.798	26.6	390.5
6.135	6	0.9	0.56	0.0	0.0	59.8	0.06	0.145	0.0335	3.695	0.850	4.31	0.172	0.0318	4.364	0.808	28.2	408.1

MTD (mm) M = 3.645 SD = 0.0913 H = 3.701 L = 3.540
MPD (mm) M = 4.302 SD = 0.1141 H = 4.372 L = 4.170
Left Wheel N = 3 M = 0.9 SD = 0.03 H = 1.0 L = 0.9

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
8.467	7	0.9	0.47	0.0	0.0	59.9	0.10	0.171	0.0501	4.353	1.272	4.85	0.204	0.0526	5.187	1.336	35.1	482.9
8.651	8	0.9	0.45	0.0	0.0	59.5	0.06	0.168	0.0420	4.266	1.067	4.82	0.200	0.0425	5.079	1.079	34.2	473.0
8.835	9	0.8	0.45	0.0	0.0	59.6	0.07	0.179	0.0458	4.541	1.162	4.26	0.213	0.0472	5.422	1.199	37.1	504.2

MTD (mm) M = 4.387 SD = 0.1404 H = 4.541 L = 4.266
MPD (mm) M = 5.229 SD = 0.1755 H = 5.422 L = 5.079
Left Wheel N = 3 M = 0.9 SD = 0.06 H = 0.9 L = 0.8

ASTM REP 2	DATE 03/23/04		RIB TIRE		60 MPH															
TEST	REF.	CYCLE	FN				SPEED		MTD				%	MPD				IFI	
SECT.	POST	NUM.	AVG	STD	PEAK	VALLEY	AVG	STD	(in)	STD. (in)	(mm)	STD. (mm)	ERROR	(in)	STD. (in)	(mm)	STD. (mm)	F60	Sp
#1 FC-3																			
	N		0				0		0		0			0		0		0	0
	Mean		n/a				n/a		n/a		n/a			n/a		n/a		n/a	n/a
	Std.		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
	Hi		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
	Lo		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
#2 FC-2	0.019	1	0.8	0.52	0.0	0.0	60.5	0.05	0.124	0.025	3.138	0.644	2.12	0.144	0.022	3.669	0.551	22.4	344.9
	0.196	2	0.7	0.49	0.0	0.0	60.0	0.04	0.122	0.027	3.093	0.684	1.98	0.142	0.024	3.613	0.601	21.9	339.8
	0.379	3	0.9	0.49	0.0	0.0	59.9	0.07	0.126	0.029	3.189	0.729	2.34	0.147	0.026	3.732	0.657	22.9	350.6
	N		3				3		3		3			3		3		3	3
	Mean		**0.8**				**60.1**		**0.124**		**3.140**			**0.144**		**3.671**		**22.4**	**345.1**
	Std.		0.1				0.3		0.002		0.048			0.003		0.060		0.5	5.4
	Hi		0.9				60.5		0.126		3.189			0.147		3.732		22.9	350.6
	Lo		0.7				59.9		0.122		3.093			0.142		3.613		21.9	339.8
#3 FC-5-OO	5.742	4	1.0	0.57	0.0	0.0	59.6	0.06	0.143	0.036	3.643	0.924	3.41	0.169	0.036	4.300	0.901	27.7	402.3
	5.949	5	1.0	0.61	0.0	0.0	59.9	0.04	0.135	0.040	3.427	1.014	2.79	0.159	0.040	4.030	1.013	25.4	377.8
	6.132	6	0.9	0.59	0.0	0.0	59.9	0.06	0.142	0.033	3.617	0.830	3.80	0.168	0.031	4.267	0.784	27.4	399.3
	N		3				3		3		3			3		3		3	3
	Mean		**1.0**				**59.8**		**0.140**		**3.562**			**0.165**		**4.199**		**26.8**	**393.1**
	Std.		0.1				0.2		0.004		0.118			0.006		0.147		1.3	13.4
	Hi		1.0				59.9		0.143		3.643			0.169		4.300		27.7	402.3
	Lo		0.9				59.6		0.135		3.427			0.159		4.030		25.4	377.8
#4 FC-5-GR	8.466	7	0.9	0.49	0.0	0.0	59.8	0.08	0.170	0.048	4.327	1.206	4.67	0.203	0.049	5.154	1.254	34.8	479.9
	8.648	8	0.9	0.49	0.0	0.0	59.7	0.06	0.171	0.041	4.335	1.042	5.24	0.203	0.041	5.165	1.049	34.9	480.9
	8.833	9	0.9	0.47	0.0	0.0	59.9	0.05	0.169	0.041	4.287	1.034	4.21	0.201	0.041	5.105	1.038	34.4	475.4
	N		3				3		3		3			3		3		3	3
	Mean		**0.9**				**59.8**		**0.170**		**4.316**			**0.202**		**5.141**		**34.7**	**478.7**
	Std.		0.0				0.1		0.001		0.026			0.001		0.032		0.3	2.9
	Hi		0.9				59.9		0.171		4.335			0.203		5.165		34.9	480.9
	Lo		0.9				59.7		0.169		4.287			0.201		5.105		34.4	475.4
#5 FC-4																			
	N		0				0		0		0			0		0		0	0
	Mean		n/a				n/a		n/a		n/a			n/a		n/a		n/a	n/a
	Std.		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
	Hi		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0
	Lo		0.0				0.0		0.000		0.000			0.000		0.000		0.0	0.0

Figure A-II-13 Summary of Laser Texture Data Collected on 03/23/04, 60 MPH, No Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\LASER04.K05
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR DIR Asc (+) LANE 0
OPERATOR AMS DRIVER AMS VEHICLE UNIT#7 EQUIPMENT MD4040/R
CO-SEC&LEG LASER04 FIN_NO. REQ_TYPE 3
DATE 03/23/2004 TIME 10:49:54 **TIRE Rib**
AIR_TEMPERATURE 58.0øF CONDITIONS DAY/CLEAR

REF CYCLE **FN** FN FN FN **SPEED** SPEED IN IN MM MM % IN IN MM MM
POST NUMBER AVG STD PEAK VALLEY AVG STD MTD MTD Std MTD MTD Std Error MPD MPD Std
MPD MPD Std F60 SP

0.019	1	**0.8**	0.52	0.0	0.0	**60.5**	0.05	0.124	0.0253	3.138	0.644	2.12	0.144	0.0217	3.669	0.551	22.4	344.9
0.196	2	0.7	0.49	0.0	0.0	60.0	0.04	0.122	0.0269	3.093	0.684	1.98	0.142	0.0236	3.613	0.601	21.9	339.8
0.379	3	0.9	0.49	0.0	0.0	59.9	0.07	0.126	0.0287	3.189	0.729	2.34	0.147	0.0259	3.732	0.657	22.9	350.6

MTD (mm) M = 3.140 SD = 0.0478 H = 3.189 L = 3.093
MPD (mm) M = 3.671 SD = 0.0597 H = 3.732 L = 3.613
Left Wheel N = 3 M = 0.8 SD = 0.06 H = 0.9 L = 0.7

5.742	4	1.0	0.57	0.0	0.0	59.6	0.06	0.143	0.0364	3.643	0.924	3.41	0.169	0.0355	4.300	0.901	27.7	402.3
5.949	5	1.0	0.61	0.0	0.0	59.9	0.04	0.135	0.0399	3.427	1.014	2.79	0.159	0.0399	4.030	1.013	25.4	377.8
6.132	6	0.9	0.59	0.0	0.0	59.9	0.06	0.142	0.0327	3.617	0.830	3.80	0.168	0.0309	4.267	0.784	27.4	399.3

MTD (mm) M = 3.563 SD = 0.1178 H = 3.643 L = 3.427
MPD (mm) M = 4.199 SD = 0.1473 H = 4.300 L = 4.030
Left Wheel N = 3 M = 1.0 SD = 0.02 H = 1.0 L = 0.9

8.466	7	0.9	0.49	0.0	0.0	59.8	0.08	0.170	0.0475	4.327	1.206	4.67	0.203	0.0494	5.154	1.254	34.8	479.9
8.648	8	0.9	0.49	0.0	0.0	59.7	0.06	0.171	0.0410	4.335	1.042	5.24	0.203	0.0413	5.165	1.049	34.9	480.9
8.833	9	0.9	0.47	0.0	0.0	59.9	0.05	0.169	0.0407	4.287	1.034	4.21	0.201	0.0409	5.105	1.038	34.4	475.4

MTD (mm) M = 4.316 SD = 0.0259 H = 4.335 L = 4.287
MPD (mm) M = 5.141 SD = 0.0324 H = 5.165 L = 5.105
Left Wheel N = 3 M = 0.9 SD = 0.04 H = 0.9 L = 0.9

ASTM	DATE 05/12/05		RIB TIRE		20 MPH														
TEST SECT.	REF. POST	CYCLE NUM.	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	MTD (in)	MTD STD. (in)	MTD (mm)	MTD STD. (mm)	% ERROR	MPD (in)	MPD STD. (in)	MPD (mm)	MPD STD. (mm)	IFI F60	IFI Sp
#1 FC-3	0.011	1	44.3	0.96	79.7	26.6	19.9	0.06	0.040	0.012	1.007	0.315	0.00	0.040	0.006	1.005	0.140	0.0	102.8
	0.121	2	43.0	0.51	78.9	26.3	19.2	0.18	0.039	0.011	1.001	0.286	0.00	0.039	0.004	0.997	0.103	0.0	102.1
	0.214	3	43.2	0.36	73.1	24.4	19.4	0.09	0.040	0.012	1.022	0.297	0.00	0.040	0.005	1.023	0.117	0.1	104.5
	0.294	4	42.8	0.68	74.1	24.8	19.4	0.07	0.044	0.014	1.121	0.359	0.00	0.045	0.008	1.147	0.195	1.2	115.7
	0.435	5	45.3	0.52	75.2	25.1	20.0	0.09	0.049	0.015	1.246	0.390	0.01	0.051	0.009	1.303	0.234	2.5	129.9
	N		5				5		5		5			5		5		5	5
	Mean		**43.7**				**19.6**		**0.042**		**1.079**			**0.043**		**1.095**		**0.8**	**111.0**
	Std.		1.1				0.3		0.004		0.105			0.005		0.131		1.1	11.9
	Hi		45.3				20.0		0.049		1.246			0.051		1.303		2.5	129.9
	Lo		42.8				19.2		0.039		1.001			0.039		0.997		0.0	102.1
#2 FC-2	1.117	6	44.1	0.47	79.3	26.5	21.0	0.18	0.123	0.028	3.114	0.718	1.22	0.143	0.025	3.638	0.644	22.1	342.1
	1.203	7	43.9	0.30	72.2	24.1	20.5	0.06	0.117	0.037	2.981	0.946	0.90	0.137	0.037	3.473	0.929	20.7	327.1
	1.293	8	46.3	0.44	73.0	24.4	21.0	0.16	0.126	0.033	3.205	0.830	0.97	0.148	0.031	3.753	0.784	23.1	352.5
	1.384	9	41.9	0.70	71.1	23.8	20.8	0.28	0.119	0.028	3.031	0.710	1.42	0.139	0.025	3.534	0.633	21.2	332.7
	1.475	10	43.8	0.99	70.2	23.5	20.1	0.11	0.128	0.030	3.257	0.750	1.36	0.150	0.027	3.817	0.684	23.6	358.4
	N		5				5		5		5			5		5		5	5
	Mean		**44.0**				**20.7**		**0.123**		**3.118**			**0.143**		**3.643**		**22.1**	**342.6**
	Std.		1.6				0.4		0.005		0.115			0.006		0.144		1.2	13.1
	Hi		46.3				21.0		0.128		3.257			0.150		3.817		23.6	358.4
	Lo		41.9				20.1		0.117		2.981			0.137		3.473		20.7	327.1
#3 FC-5-OO	6.827	11	59.6	1.43	0.0	0.0	20.1	0.32	0.148	0.046	3.770	1.171	3.26	0.176	0.048	4.458	1.210	29.0	416.6
	6.933	12	55.4	1.21	0.0	0.0	19.9	0.34	0.129	0.038	3.281	0.952	2.21	0.151	0.037	3.847	0.936	23.8	361.1
	7.032	13	53.4	1.23	0.0	0.0	20.1	0.12	0.132	0.037	3.354	0.928	2.32	0.155	0.036	3.938	0.906	24.6	369.4
	7.125	14	51.0	1.15	0.0	0.0	20.1	0.09	0.124	0.031	3.162	0.796	2.10	0.146	0.029	3.699	0.741	22.6	347.6
	7.216	15	49.4	1.22	0.0	0.0	20.0	0.29	0.134	0.037	3.408	0.934	3.05	0.158	0.036	4.006	0.914	25.2	375.5
	N		5				5		5		5			5		5		5	5
	Mean		**53.8**				**20.0**		**0.133**		**3.395**			**0.157**		**3.990**		**25.0**	**374.0**
	Std.		4.0				0.1		0.009		0.229			0.011		0.286		2.4	26.0
	Hi		59.6				20.1		0.148		3.770			0.176		4.458		29.0	416.6
	Lo		49.4				19.9		0.124		3.162			0.146		3.699		22.6	347.6
#4 FC-5-GR	9.543	16	50.1	1.04	0.0	0.0	21.5	0.06	0.164	0.047	4.158	1.183	3.82	0.195	0.048	4.943	1.225	33.1	460.7
	9.650	17	49.3	1.11	0.0	0.0	19.9	0.19	0.156	0.035	3.970	0.900	1.95	0.185	0.034	4.708	0.870	31.1	439.4
	9.726	18	47.7	0.87	0.0	0.0	21.2	0.15	0.175	0.046	4.445	1.178	4.39	0.209	0.048	5.302	1.218	36.1	493.3
	9.809	19	48.6	0.94	0.0	0.0	19.7	0.10	0.164	0.045	4.159	1.145	4.08	0.195	0.046	4.944	1.178	33.1	460.8
	9.910	20	47.3	1.14	0.0	0.0	20.1	0.09	0.163	0.040	4.130	1.027	3.71	0.193	0.041	4.909	1.030	32.8	457.6
	N		5				5		5		5			5		5		5	5
	Mean		**48.6**				**20.5**		**0.164**		**4.172**			**0.195**		**4.961**		**33.2**	**462.4**
	Std.		1.1				0.8		0.007		0.171			0.009		0.214		1.8	19.4
	Hi		50.1				21.5		0.175		4.445			0.209		5.302		36.1	493.3
	Lo		47.3				19.7		0.156		3.970			0.185		4.708		31.1	439.4
#5 FC-4	19.728	21	44.8	1.01	0.0	0.0	21.6	0.30	0.051	0.014	1.283	0.360	0.00	0.053	0.008	1.350	0.196	2.9	134.2
	19.800	22	43.4	1.00	0.0	0.0	20.1	0.16	0.050	0.012	1.259	0.309	0.01	0.052	0.005	1.320	0.132	2.6	131.4
	19.872	23	49.4	1.29	0.0	0.0	19.9	0.11	0.059	0.020	1.489	0.511	0.01	0.063	0.015	1.607	0.384	5.0	157.5
	19.940	24	53.7	1.04	0.0	0.0	20.6	0.14	0.054	0.013	1.363	0.320	0.03	0.057	0.006	1.450	0.146	3.7	143.3
	20.013	25	60.0	1.40	0.0	0.0	21.0	0.17	0.052	0.013	1.329	0.326	0.01	0.055	0.006	1.407	0.154	3.4	139.3
	N		5				5		5		5			5		5		5	5
	Mean		**50.3**				**20.6**		**0.053**		**1.345**			**0.056**		**1.427**		**3.5**	**141.1**
	Std.		6.8				0.7		0.004		0.090			0.004		0.113		0.9	10.2
	Hi		60.0				21.6		0.059		1.489			0.063		1.607		5.0	157.5
	Lo		43.4				19.9		0.050		1.259			0.052		1.320		2.6	131.4

Figure A-II-14 Summary of Laser Texture Data Collected on 05/12/05, 20 MPH, with Ribbed Tire Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\26050.K01
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR-24 DIR North(+) LANE 1
OPERATOR DLB DRIVER DLB VEHICLE UNIT#7 EQUIPMENT MD5041/R
CO-SEC&LEG 26050 FIN_NO. REQ_TYPE SECTIONS
DATE 05/12/2005 TIME 14:03:13 **TIRE Rib**
AIR_TEMPERATURE 82.0øF CONDITIONS DAY/CLear

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
0.011	1	**44.3**	0.96	79.7	26.6	**19.9**	0.06	0.040	0.0124	1.007	0.315	0.00	0.040	0.0055	1.005	0.140	0.0	102.8
0.121	2	43.0	0.51	78.9	26.3	19.2	0.18	0.039	0.0113	1.001	0.286	0.00	0.039	0.0041	0.997	0.103	0.0	102.1
0.214	3	43.2	0.36	73.1	24.4	19.4	0.09	0.040	0.0117	1.022	0.297	0.00	0.040	0.0046	1.023	0.117	0.1	104.5
0.294	4	42.8	0.68	74.1	24.8	19.4	0.07	0.044	0.0141	1.121	0.359	0.00	0.045	0.0077	1.147	0.195	1.2	115.7
0.435	5	45.3	0.52	75.2	25.1	20.0	0.09	0.049	0.0154	1.246	0.390	0.01	0.051	0.0092	1.303	0.234	2.5	129.9

MTD (mm) M = 1.079 SD = 0.1049 H = 1.246 L = 1.001
MPD (mm) M = 1.095 SD = 0.1312 H = 1.303 L = 0.997
Left Wheel N = 5 M = 43.7 SD = 1.05 H = 45.3 L = 42.8

1.117	6	44.1	0.47	79.3	26.5	21.0	0.18	0.123	0.0283	3.114	0.718	1.22	0.143	0.0254	3.638	0.644	22.1	342.1
1.203	7	43.9	0.30	72.2	24.1	20.5	0.06	0.117	0.0373	2.981	0.946	0.90	0.137	0.0366	3.473	0.929	20.7	327.1
1.293	8	46.3	0.44	73.0	24.4	21.0	0.16	0.126	0.0327	3.205	0.830	0.97	0.148	0.0308	3.753	0.784	23.1	352.5
1.384	9	41.9	0.70	71.1	23.8	20.8	0.28	0.119	0.0279	3.031	0.710	1.42	0.139	0.0249	3.534	0.633	21.2	332.7
1.475	10	43.8	0.99	70.2	23.5	20.1	0.11	0.128	0.0295	3.257	0.750	1.36	0.150	0.0269	3.817	0.684	23.6	358.4

MTD (mm) M = 3.118 SD = 0.1155 H = 3.257 L = 2.981
MPD (mm) M = 3.643 SD = 0.1443 H = 3.817 L = 3.473
Left Wheel N = 5 M = 44.0 SD = 1.54 H = 46.3 L = 41.9

6.827	11	59.6	1.43	0.0	0.0	20.1	0.32	0.148	0.0461	3.770	1.171	3.26	0.176	0.0476	4.458	1.210	29.0	416.6
6.933	12	55.4	1.21	0.0	0.0	19.9	0.34	0.129	0.0375	3.281	0.952	2.21	0.151	0.0368	3.847	0.936	23.8	361.1
7.032	13	53.4	1.23	0.0	0.0	20.1	0.12	0.132	0.0365	3.354	0.928	2.32	0.155	0.0357	3.938	0.906	24.6	369.4
7.125	14	51.0	1.15	0.0	0.0	20.1	0.09	0.124	0.0313	3.162	0.796	2.10	0.146	0.0292	3.699	0.741	22.6	347.6
7.216	15	49.4	1.22	0.0	0.0	20.0	0.29	0.134	0.0368	3.408	0.934	3.05	0.158	0.0360	4.006	0.914	25.2	375.5

MTD (mm) M = 3.395 SD = 0.2288 H = 3.770 L = 3.162
MPD (mm) M = 3.989 SD = 0.2860 H = 4.458 L = 3.699
Left Wheel N = 5 M = 53.7 SD = 3.99 H = 59.6 L = 49.4

9.543	16	50.1	1.04	0.0	0.0	21.5	0.06	0.164	0.0466	4.158	1.183	3.82	0.195	0.0482	4.943	1.225	33.1	460.7
9.650	17	49.3	1.11	0.0	0.0	19.9	0.19	0.156	0.0354	3.970	0.900	1.95	0.185	0.0343	4.708	0.870	31.1	439.4
9.726	18	47.7	0.87	0.0	0.0	21.2	0.15	0.175	0.0464	4.445	1.178	4.39	0.209	0.0480	5.302	1.218	36.1	493.3
9.809	19	48.6	0.94	0.0	0.0	19.7	0.10	0.164	0.0451	4.159	1.145	4.08	0.195	0.0464	4.944	1.178	33.1	460.8
9.910	20	47.3	1.14	0.0	0.0	20.1	0.09	0.163	0.0404	4.130	1.027	3.71	0.193	0.0405	4.909	1.030	32.8	457.6

MTD (mm) M = 4.172 SD = 0.1713 H = 4.445 L = 3.970
MPD (mm) M = 4.961 SD = 0.2141 H = 5.302 L = 4.708
Left Wheel N = 5 M = 48.6 SD = 1.16 H = 50.1 L = 47.3

19.728	21	44.8	1.01	0.0	0.0	21.6	0.30	0.051	0.0142	1.283	0.360	0.00	0.053	0.0077	1.350	0.196	2.9	134.2
19.800	22	43.4	1.00	0.0	0.0	20.1	0.16	0.050	0.0122	1.259	0.309	0.01	0.052	0.0052	1.320	0.132	2.6	131.4
19.872	23	49.4	1.29	0.0	0.0	19.9	0.11	0.059	0.0201	1.489	0.511	0.01	0.063	0.0151	1.607	0.384	5.0	157.5
19.940	24	53.7	1.04	0.0	0.0	20.6	0.14	0.054	0.0126	1.363	0.320	0.03	0.057	0.0058	1.450	0.146	3.7	143.3
20.013	25	60.0	1.40	0.0	0.0	21.0	0.17	0.052	0.0128	1.329	0.326	0.01	0.055	0.0060	1.407	0.154	3.4	139.3

MTD (mm) M = 1.345 SD = 0.0900 H = 1.489 L = 1.259
MPD (mm) M = 1.427 SD = 0.1125 H = 1.607 L = 1.320
Left Wheel N = 5 M = 50.3 SD = 6.78 H = 60.0 L = 43.4

ASTM REP 3	DATE 05/12/05		RIB TIRE		40 MPH														
TEST	REF.	CYCLE	FN				SPEED		MTD				%	MPD				IFI	
SECT.	POST	NUM.	AVG	STD	PEAK	VALLEY	AVG	STD	(in)	STD. (in)	(mm)	STD. (mm)	ERROR	(in)	STD. (in)	(mm)	STD. (mm)	F60	Sp
#1 FC-3	0.017	1	33.7	0.54	70.4	23.5	40.6	0.05	0.043	0.013	1.089	0.327	0.00	0.044	0.006	1.107	0.155	0.8	112.1
	0.129	2	35.4	0.35	60.8	20.3	39.9	0.19	0.043	0.012	1.093	0.311	0.00	0.044	0.005	1.112	0.135	0.9	112.5
	0.220	3	33.4	0.44	59.5	19.9	41.0	0.03	0.043	0.013	1.095	0.339	0.00	0.044	0.007	1.115	0.170	0.9	112.8
	0.304	4	34.3	0.26	55.2	18.4	38.7	0.11	0.047	0.015	1.181	0.383	0.00	0.048	0.009	1.223	0.225	1.8	122.6
	0.442	5	35.0	0.40	65.5	21.9	40.3	0.04	0.044	0.016	1.118	0.406	0.00	0.045	0.010	1.144	0.254	1.1	115.4
	N		5				5		5		5			5		5		5	5
	Mean		**34.4**				**40.1**		**0.044**		**1.115**			**0.045**		**1.140**		**1.1**	**115.1**
	Std.		0.8				0.9		0.002		0.038			0.002		0.048		0.4	4.4
	Hi		35.4				41.0		0.047		1.181			0.048		1.223		1.8	122.6
	Lo		33.4				38.7		0.043		1.089			0.044		1.107		0.8	112.1
#2 FC-2	1.120	6	38.0	0.63	72.8	24.4	39.4	0.03	0.122	0.031	3.107	0.787	1.40	0.143	0.029	3.629	0.730	22.0	341.3
	1.211	7	35.8	0.36	59.7	20.0	40.8	0.04	0.108	0.031	2.741	0.795	1.19	0.125	0.029	3.173	0.739	18.2	299.8
	1.300	8	40.4	0.62	61.2	20.5	38.2	0.13	0.129	0.027	3.269	0.672	1.60	0.151	0.023	3.833	0.586	23.7	359.8
	1.391	9	36.8	0.70	58.2	19.4	39.9	0.13	0.118	0.026	3.002	0.651	1.47	0.138	0.022	3.499	0.560	20.9	329.5
	1.482	10	38.4	0.58	56.8	18.9	39.7	0.22	0.123	0.030	3.120	0.757	1.56	0.144	0.027	3.646	0.692	22.2	342.9
	N		5				5		5		5			5		5		5	5
	Mean		**37.9**				**39.6**		**0.120**		**3.048**			**0.140**		**3.556**		**21.4**	**334.7**
	Std.		1.7				0.9		0.008		0.196			0.010		0.245		2.0	22.3
	Hi		40.4				40.8		0.129		3.269			0.151		3.833		23.7	359.8
	Lo		35.8				38.2		0.108		2.741			0.125		3.173		18.2	299.8
#3 FC-5-OO	6.828	11	36.6	0.90	72.2	24.1	38.7	0.04	0.146	0.033	3.706	0.831	3.14	0.172	0.031	4.378	0.785	28.3	409.4
	6.937	12	36.7	0.56	58.4	19.5	40.4	0.05	0.139	0.040	3.530	1.017	3.12	0.164	0.040	4.159	1.017	26.5	389.4
	7.033	13	35.6	0.76	54.4	18.2	38.3	0.10	0.123	0.036	3.127	0.906	2.65	0.144	0.035	3.655	0.878	22.2	343.7
	7.127	14	33.8	0.51	52.5	17.5	40.6	0.05	0.129	0.035	3.288	0.900	2.46	0.152	0.034	3.856	0.871	23.9	361.9
	7.217	15	34.4	0.64	54.0	18.1	38.9	0.04	0.138	0.042	3.503	1.067	3.81	0.162	0.043	4.125	1.079	26.2	386.3
	N		5				5		5		5			5		5		5	5
	Mean		**35.4**				**39.4**		**0.135**		**3.431**			**0.159**		**4.035**		**25.4**	**378.1**
	Std.		1.3				1.0		0.009		0.226			0.011		0.282		2.4	25.6
	Hi		36.7				40.6		0.146		3.706			0.172		4.378		28.3	409.4
	Lo		33.8				38.3		0.123		3.127			0.144		3.655		22.2	343.7
#4 FC-5-GR	9.546	16	44.2	0.75	78.5	26.2	38.8	0.05	0.162	0.045	4.109	1.130	4.85	0.192	0.046	4.883	1.158	32.5	455.2
	9.654	17	42.5	0.68	69.2	23.1	38.7	0.15	0.159	0.045	4.028	1.130	2.94	0.188	0.046	4.781	1.158	31.7	446.0
	9.729	18	43.5	0.59	68.7	23.0	40.5	0.03	0.182	0.042	4.635	1.075	5.14	0.218	0.043	5.540	1.090	38.1	515.0
	9.814	19	42.3	0.53	68.4	22.9	39.9	0.05	0.162	0.038	4.117	0.957	4.81	0.193	0.037	4.893	0.942	32.6	456.1
	9.912	20	42.8	0.74	66.1	22.0	39.9	0.05	0.155	0.040	3.943	1.010	4.09	0.184	0.040	4.675	1.008	30.8	436.3
	N		5				5		5		5			5		5		5	5
	Mean		**43.1**				**39.6**		**0.164**		**4.166**			**0.195**		**4.954**		**33.1**	**461.7**
	Std.		0.8				0.8		0.010		0.271			0.013		0.339		2.9	30.8
	Hi		44.2				40.5		0.182		4.635			0.218		5.540		38.1	515.0
	Lo		42.3				38.7		0.155		3.943			0.184		4.675		30.8	436.3
#5 FC-4	20.088	21	53.0	0.86	90.8	30.3	40.0	0.04	0.050	0.014	1.265	0.347	0.03	0.052	0.007	1.328	0.179	2.7	132.1
	20.158	22	48.8	0.74	79.5	26.5	40.3	0.05	0.050	0.013	1.282	0.316	0.00	0.053	0.006	1.348	0.141	2.9	134.0
	20.231	23	51.8	0.99	81.0	27.0	40.4	0.07	0.055	0.014	1.388	0.355	0.00	0.058	0.008	1.482	0.190	4.0	146.1
	20.299	24	52.8	1.33	81.6	27.3	41.0	0.08	0.054	0.021	1.365	0.532	0.00	0.057	0.016	1.452	0.411	3.7	143.4
	20.371	25	51.4	1.04	82.2	27.4	41.5	0.04	0.054	0.016	1.360	0.408	0.00	0.057	0.010	1.446	0.256	3.7	142.9
	N		5				5		5		5			5		5		5	5
	Mean		**51.6**				**40.6**		**0.053**		**1.332**			**0.055**		**1.411**		**3.4**	**139.7**
	Std.		1.7				0.6		0.002		0.055			0.003		0.069		0.6	6.2
	Hi		53.0				41.5		0.055		1.388			0.058		1.482		4.0	146.1
	Lo		48.8				40.0		0.050		1.265			0.052		1.328		2.7	132.1

Figure A-II-15 **Summary of Laser Texture Data Collected on 05/12/05, 40 MPH, with Ribbed Tire Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).**

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\26050.K02
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR-24 DIR North(+) LANE 1
OPERATOR DLB DRIVER DLB VEHICLE UNIT#7 EQUIPMENT MD5041/R
CO-SEC&LEG 26050 FIN_NO. REQ_TYPE SECTIONS
DATE 05/12/2005 TIME 14:39:22 **TIRE Rib**
AIR_TEMPERATURE 82.0øF CONDITIONS DAY/CLear

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
0.017	1	**33.7**	0.54	70.4	23.5	**40.6**	0.05	0.043	0.0129	1.089	0.327	0.00	0.044	0.0061	1.107	0.155	0.8	112.1
0.129	2	35.4	0.35	60.8	20.3	39.9	0.19	0.043	0.0122	1.093	0.311	0.00	0.044	0.0053	1.112	0.135	0.9	112.5
0.220	3	33.4	0.44	59.5	19.9	41.0	0.03	0.043	0.0133	1.095	0.339	0.00	0.044	0.0067	1.115	0.170	0.9	112.8
0.304	4	34.3	0.26	55.2	18.4	38.7	0.11	0.047	0.0151	1.181	0.383	0.00	0.048	0.0089	1.223	0.225	1.8	122.6
0.442	5	35.0	0.40	65.5	21.9	40.3	0.04	0.044	0.0160	1.118	0.406	0.00	0.045	0.0100	1.144	0.254	1.1	115.4

MTD (mm) M = 1.115 SD = 0.0387 H = 1.181 L = 1.089
MPD (mm) M = 1.140 SD = 0.0483 H = 1.223 L = 1.107
Left Wheel N = 5 M = 34.3 SD = 0.83 H = 35.4 L = 33.4

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
1.120	6	38.0	0.63	72.8	24.4	39.4	0.03	0.122	0.0310	3.107	0.787	1.40	0.143	0.0287	3.629	0.730	22.0	341.3
1.211	7	35.8	0.36	59.7	20.0	40.8	0.04	0.108	0.0313	2.741	0.795	1.19	0.125	0.0291	3.173	0.739	18.2	299.8
1.300	8	40.4	0.62	61.2	20.5	38.2	0.13	0.129	0.0265	3.269	0.672	1.60	0.151	0.0231	3.833	0.586	23.7	359.8
1.391	9	36.8	0.70	58.2	19.4	39.9	0.13	0.118	0.0256	3.002	0.651	1.47	0.138	0.0221	3.499	0.560	20.9	329.5
1.482	10	38.4	0.58	56.8	18.9	39.7	0.22	0.123	0.0298	3.120	0.757	1.56	0.144	0.0272	3.646	0.692	22.2	342.9

MTD (mm) M = 3.048 SD = 0.1961 H = 3.269 L = 2.741
MPD (mm) M = 3.556 SD = 0.2451 H = 3.833 L = 3.173
Left Wheel N = 5 M = 37.9 SD = 1.74 H = 40.4 L = 35.8

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
6.828	11	36.6	0.90	72.2	24.1	38.7	0.04	0.146	0.0327	3.706	0.831	3.14	0.172	0.0309	4.378	0.785	28.3	409.4
6.937	12	36.7	0.56	58.4	19.5	40.4	0.05	0.139	0.0400	3.530	1.017	3.12	0.164	0.0400	4.159	1.017	26.5	389.4
7.033	13	35.6	0.76	54.4	18.2	38.3	0.10	0.123	0.0357	3.127	0.906	2.65	0.144	0.0346	3.655	0.878	22.2	343.7
7.127	14	33.8	0.51	52.5	17.5	40.6	0.05	0.129	0.0354	3.288	0.900	2.46	0.152	0.0343	3.856	0.871	23.9	361.9
7.217	15	34.4	0.64	54.0	18.1	38.9	0.04	0.138	0.0420	3.503	1.067	3.81	0.162	0.0425	4.125	1.079	26.2	386.3

MTD (mm) M = 3.431 SD = 0.2254 H = 3.706 L = 3.127
MPD (mm) M = 4.035 SD = 0.2817 H = 4.378 L = 3.655
Left Wheel N = 5 M = 35.4 SD = 1.28 H = 36.7 L = 33.8

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
9.546	16	44.2	0.75	78.5	26.2	38.8	0.05	0.162	0.0445	4.109	1.130	4.85	0.192	0.0456	4.883	1.158	32.5	455.2
9.654	17	42.5	0.68	69.2	23.1	38.7	0.15	0.159	0.0445	4.028	1.130	2.94	0.188	0.0456	4.781	1.158	31.7	446.0
9.729	18	43.5	0.59	68.7	23.0	40.5	0.03	0.182	0.0423	4.635	1.075	5.14	0.218	0.0429	5.540	1.090	38.1	515.0
9.814	19	42.3	0.53	68.4	22.9	39.9	0.05	0.162	0.0377	4.117	0.957	4.81	0.193	0.0371	4.893	0.942	32.6	456.1
9.912	20	42.8	0.74	66.1	22.0	39.9	0.05	0.155	0.0398	3.943	1.010	4.09	0.184	0.0397	4.675	1.008	30.8	436.3

MTD (mm) M = 4.167 SD = 0.2713 H = 4.635 L = 3.943
MPD (mm) M = 4.954 SD = 0.3391 H = 5.540 L = 4.675
Left Wheel N = 5 M = 43.0 SD = 0.79 H = 44.2 L = 42.3

REF POST	CYCLE NUMBER	FN AVG	FN STD	FN PEAK	FN VALLEY	SPEED AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Std Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
20.088	21	53.0	0.86	90.8	30.3	40.0	0.04	0.050	0.0136	1.265	0.347	0.03	0.052	0.0071	1.328	0.179	2.7	132.1
20.158	22	48.8	0.74	79.5	26.5	40.3	0.05	0.050	0.0125	1.282	0.316	0.00	0.053	0.0056	1.348	0.141	2.9	134.0
20.231	23	51.8	0.99	81.0	27.0	40.4	0.07	0.055	0.0140	1.388	0.355	0.00	0.058	0.0075	1.482	0.190	4.0	146.1
20.299	24	52.8	1.33	81.6	27.3	41.0	0.08	0.054	0.0209	1.365	0.532	0.00	0.057	0.0162	1.452	0.411	3.7	143.4
20.371	25	51.4	1.04	82.2	27.4	41.5	0.04	0.054	0.0161	1.360	0.408	0.00	0.057	0.0101	1.446	0.256	3.7	142.9

MTD (mm) M = 1.332 SD = 0.0548 H = 1.388 L = 1.265
MPD (mm) M = 1.411 SD = 0.0685 H = 1.482 L = 1.328
Left Wheel N = 5 M = 51.5 SD = 1.69 H = 53.0 L = 48.8

ASTM DATE 05/12/05 RIB TIRE 60 MPH

TEST	REF.	CYCLE	FN				SPEED		MTD				%	MPD				IFI	
SECT.	POST	NUM.	AVG	STD	PEAK	VALLEY	AVG	STD	(in)	STD. (in)	(mm)	STD. (mm)	ERROR	(in)	STD. (in)	(mm)	STD. (mm)	F60	Sp
#1 FC-3	0.026	1	29.8	0.72	63.1	21.1	58.0	0.28	0.045	0.013	1.155	0.333	0.00	0.047	0.006	1.190	0.163	1.5	119.6
	0.135	2	30.5	0.44	54.0	18.0	57.3	0.26	0.046	0.015	1.160	0.371	0.00	0.047	0.008	1.195	0.209	1.6	120.1
	0.229	3	31.0	0.53	53.4	17.8	57.7	0.10	0.047	0.014	1.187	0.363	0.00	0.048	0.008	1.229	0.199	1.9	123.2
	0.306	4	33.0	0.29	52.7	17.6	55.5	0.07	0.050	0.016	1.262	0.397	0.00	0.052	0.010	1.323	0.243	2.6	131.8
	0.448	5	30.0	0.31	54.8	18.3	57.4	0.08	0.048	0.016	1.211	0.395	0.00	0.050	0.009	1.260	0.239	2.1	126.0
	N		5				5		5		5			5		5		5	5
	Mean		**30.9**				**57.2**		**0.047**		**1.195**			**0.049**		**1.239**		**1.9**	**124.1**
	Std.		1.3				1.0		0.002		0.044			0.002		0.055		0.4	5.0
	Hi		33.0				58.0		0.050		1.262			0.052		1.323		2.6	131.8
	Lo		29.8				55.5		0.045		1.155			0.047		1.190		1.5	119.6
#2 FC-2	1.130	6	37.1	0.61	67.6	22.6	57.4	0.09	0.120	0.029	3.058	0.723	1.48	0.140	0.026	3.568	0.650	21.5	335.8
	1.219	7	34.8	0.53	58.0	19.4	58.7	0.07	0.114	0.026	2.889	0.659	1.41	0.132	0.022	3.357	0.569	19.7	316.6
	1.307	8	36.6	0.56	55.8	18.7	58.5	0.09	0.125	0.030	3.178	0.754	1.57	0.146	0.027	3.718	0.688	22.8	349.4
	1.397	9	35.2	0.78	53.9	18.0	58.3	0.20	0.118	0.026	2.993	0.670	1.31	0.137	0.023	3.487	0.583	20.8	328.4
	1.490	10	34.6	0.61	53.1	17.8	58.6	0.04	0.123	0.026	3.134	0.671	1.46	0.144	0.023	3.663	0.585	22.3	344.4
	N		5				5		5		5			5		5		5	5
	Mean		**35.7**				**58.3**		**0.120**		**3.050**			**0.140**		**3.559**		**21.4**	**334.9**
	Std.		1.1				0.5		0.004		0.115			0.006		0.143		1.2	13.0
	Hi		37.1				58.7		0.125		3.178			0.146		3.718		22.8	349.4
	Lo		34.6				57.4		0.114		2.889			0.132		3.357		19.7	316.6
#3 FC-5-OO	6.835	11	33.7	0.57	67.7	22.6	59.3	0.11	0.137	0.037	3.467	0.951	3.30	0.161	0.037	4.080	0.935	25.8	382.3
	6.942	12	32.8	0.47	53.0	17.7	59.0	0.08	0.144	0.037	3.667	0.949	3.78	0.170	0.037	4.330	0.933	27.9	405.0
	7.042	13	31.7	0.54	51.9	17.3	58.4	0.06	0.134	0.039	3.396	0.998	3.21	0.157	0.039	3.991	0.994	25.1	374.2
	7.134	14	32.4	0.43	48.9	16.3	59.1	0.04	0.132	0.037	3.352	0.942	2.98	0.155	0.036	3.936	0.923	24.6	369.2
	7.226	15	33.7	0.40	48.5	16.2	59.3	0.09	0.133	0.034	3.369	0.866	3.39	0.156	0.033	3.957	0.828	24.8	371.1
	N		5				5		5		5			5		5		5	5
	Mean		**32.9**				**59.0**		**0.136**		**3.450**			**0.160**		**4.059**		**25.6**	**380.4**
	Std.		0.9				0.4		0.005		0.129			0.006		0.161		1.3	14.7
	Hi		33.7				59.3		0.144		3.667			0.170		4.330		27.9	405.0
	Lo		31.7				58.4		0.132		3.352			0.155		3.936		24.6	369.2
#4 FC-5-GR	9.550	16	40.0	1.15	73.4	24.5	58.4	0.11	0.167	0.051	4.234	1.282	5.84	0.198	0.053	5.039	1.348	33.9	469.4
	9.658	17	38.7	0.83	67.9	22.6	56.4	0.13	0.160	0.041	4.054	1.048	2.59	0.189	0.042	4.813	1.056	32.0	448.9
	9.734	18	41.9	0.80	64.5	21.5	55.4	0.04	0.179	0.053	4.545	1.354	4.79	0.214	0.057	5.428	1.438	37.1	504.8
	9.818	19	39.2	1.05	62.1	20.8	57.3	0.05	0.158	0.043	4.023	1.090	4.09	0.188	0.044	4.775	1.108	31.6	445.4
	9.919	20	38.1	0.54	60.8	20.3	59.3	0.11	0.153	0.045	3.879	1.138	3.83	0.181	0.046	4.595	1.168	30.1	429.1
	N		5				5		5		5			5		5		5	5
	Mean		**39.6**				**57.4**		**0.163**		**4.147**			**0.194**		**4.930**		**32.9**	**459.5**
	Std.		1.5				1.6		0.010		0.256			0.013		0.320		2.7	29.1
	Hi		41.9				59.3		0.179		4.545			0.214		5.428		37.1	504.8
	Lo		38.1				55.4		0.153		3.879			0.181		4.595		30.1	429.1
#5 FC-4	20.989	24	43.6	1.45	81.8	27.3	58.5	0.11	0.058	0.016	1.479	0.413	0.22	0.063	0.010	1.595	0.262	4.9	156.4
	21.054	25	44.0	0.93	72.0	24.0	58.4	0.06	0.053	0.013	1.335	0.341	0.02	0.056	0.007	1.414	0.172	3.4	140.0
	21.128	26	48.0	1.64	77.3	25.8	59.0	0.07	0.065	0.020	1.649	0.515	0.41	0.071	0.015	1.807	0.389	6.7	175.7
	21.197	27	48.5	2.05	77.3	25.8	59.1	0.07	0.054	0.015	1.359	0.376	0.02	0.057	0.009	1.445	0.216	3.7	142.8
	21.269	28	46.5	1.49	71.5	23.8	59.9	0.06	0.054	0.013	1.364	0.320	0.00	0.057	0.006	1.450	0.146	3.7	143.3
	N		5				5		5		5			5		5		5	5
	Mean		**46.1**				**59.0**		**0.057**		**1.437**			**0.061**		**1.542**		**4.5**	**151.6**
	Std.		2.2				0.6		0.005		0.131			0.006		0.164		1.4	14.9
	Hi		48.5				59.9		0.065		1.649			0.071		1.807		6.7	175.7
	Lo		43.6				58.4		0.053		1.335			0.056		1.414		3.4	140.0

Figure A-II-16 Summary of Laser Texture Data Collected on 05/12/05, 60 MPH, with Ribbed Tire Skid Test, as Processed with ICC WinSkid Program, in Accordance with ASTM E 1845-01 (See WinSkid Output on Following Page).

PAVEMENT FRICTION TEST RESULTS

FILE C:\DOCUMENTS AND SETTINGS\NJACKSON\DESKTOP\RESEARCH\FDOT\TEXTURE\BERTBACK\26050.K03
ENGLISH UNITS

COUNTY ALACHUA ROUTE SR-24 DIR North(+) LANE 1
OPERATOR DLB DRIVER DLB VEHICLE UNIT#7 EQUIPMENT MD5041/R
CO-SEC&LEG 26050 FIN_NO. REQ_TYPE SECTIONS
DATE 05/12/2005 TIME 15:14:18 **TIRE Rib**
AIR_TEMPERATURE 82.0øF CONDITIONS DAY/CLear

REF POST	CYCLE NUMBER	**FN** AVG	FN STD	FN PEAK	FN VALLEY	**SPEED** AVG	SPEED STD	IN MTD	IN MTD Std	MM MTD	MM MTD Std	% Error	IN MPD	IN MPD Std	MM MPD	MM MPD Std	F60	SP
0.026	1	**29.8**	0.72	63.1	21.1	**58.0**	0.28	0.045	0.0131	1.155	0.333	0.00	0.047	0.0064	1.190	0.163	1.5	119.6
0.135	2	30.5	0.44	54.0	18.0	57.3	0.26	0.046	0.0146	1.160	0.371	0.00	0.047	0.0082	1.195	0.209	1.6	120.1
0.229	3	31.0	0.53	53.4	17.8	57.7	0.10	0.047	0.0143	1.187	0.363	0.00	0.048	0.0078	1.229	0.199	1.9	123.2
0.306	4	33.0	0.29	52.7	17.6	55.5	0.07	0.050	0.0156	1.262	0.397	0.00	0.052	0.0096	1.323	0.243	2.6	131.8
0.448	5	30.0	0.31	54.8	18.3	57.4	0.08	0.048	0.0155	1.211	0.395	0.00	0.050	0.0094	1.260	0.239	2.1	126.0

MTD (mm) M = 1.195 SD = 0.0438 H = 1.262 L = 1.155
MPD (mm) M = 1.240 SD = 0.0547 H = 1.323 L = 1.190
Left Wheel N = 5 M = 30.8 SD = 1.28 H = 33.0 L = 29.8

1.130	6	37.1	0.61	67.6	22.6	57.4	0.09	0.120	0.0285	3.058	0.723	1.48	0.140	0.0256	3.568	0.650	21.5	335.8
1.219	7	34.8	0.53	58.0	19.4	58.7	0.07	0.114	0.0259	2.889	0.659	1.41	0.132	0.0224	3.357	0.569	19.7	316.6
1.307	8	36.6	0.56	55.8	18.7	58.5	0.09	0.125	0.0297	3.178	0.754	1.57	0.146	0.0271	3.718	0.688	22.8	349.4
1.397	9	35.2	0.78	53.9	18.0	58.3	0.20	0.118	0.0264	2.993	0.670	1.31	0.137	0.0230	3.487	0.583	20.8	328.4
1.490	10	34.6	0.61	53.1	17.8	58.6	0.04	0.123	0.0264	3.134	0.671	1.46	0.144	0.0230	3.663	0.585	22.3	344.4

MTD (mm) M = 3.050 SD = 0.1147 H = 3.178 L = 2.889
MPD (mm) M = 3.559 SD = 0.1434 H = 3.718 L = 3.357
Left Wheel N = 5 M = 35.7 SD = 1.11 H = 37.1 L = 34.6

6.835	11	33.7	0.57	67.7	22.6	59.3	0.11	0.137	0.0374	3.467	0.951	3.30	0.161	0.0368	4.080	0.935	25.8	382.3
6.942	12	32.8	0.47	53.0	17.7	59.0	0.08	0.144	0.0374	3.667	0.949	3.78	0.170	0.0367	4.330	0.933	27.9	405.0
7.042	13	31.7	0.54	51.9	17.3	58.4	0.06	0.134	0.0393	3.396	0.998	3.21	0.157	0.0391	3.991	0.994	25.1	374.2
7.134	14	32.4	0.43	48.9	16.3	59.1	0.04	0.132	0.0371	3.352	0.942	2.98	0.155	0.0363	3.936	0.923	24.6	369.2
7.226	15	33.7	0.40	48.5	16.2	59.3	0.09	0.133	0.0341	3.369	0.866	3.39	0.156	0.0326	3.957	0.828	24.8	371.1

MTD (mm) M = 3.450 SD = 0.1290 H = 3.667 L = 3.352
MPD (mm) M = 4.059 SD = 0.1612 H = 4.330 L = 3.936
Left Wheel N = 5 M = 32.9 SD = 0.87 H = 33.7 L = 31.7

9.550	16	40.0	1.15	73.4	24.5	58.4	0.11	0.167	0.0505	4.234	1.282	5.84	0.198	0.0531	5.039	1.348	33.9	469.4
9.658	17	38.7	0.83	67.9	22.6	56.4	0.13	0.160	0.0413	4.054	1.048	2.59	0.189	0.0416	4.813	1.056	32.0	448.9
9.734	18	41.9	0.80	64.5	21.5	55.4	0.04	0.179	0.0533	4.545	1.354	4.79	0.214	0.0566	5.428	1.438	37.1	504.8
9.818	19	39.2	1.05	62.1	20.8	57.3	0.05	0.158	0.0429	4.023	1.090	4.09	0.188	0.0436	4.775	1.108	31.6	445.4
9.919	20	38.1	0.54	60.8	20.3	59.3	0.11	0.153	0.0448	3.879	1.138	3.83	0.181	0.0460	4.595	1.168	30.1	429.1

MTD (mm) M = 4.147 SD = 0.2560 H = 4.545 L = 3.879
MPD (mm) M = 4.930 SD = 0.3200 H = 5.428 L = 4.595
Left Wheel N = 5 M = 39.6 SD = 1.47 H = 41.9 L = 38.1

20.989	24	43.6	1.45	81.8	27.3	58.5	0.11	0.058	0.0163	1.479	0.413	0.22	0.063	0.0103	1.595	0.262	4.9	156.4
21.054	25	44.0	0.93	72.0	24.0	58.4	0.06	0.053	0.0134	1.335	0.341	0.02	0.056	0.0068	1.414	0.172	3.4	140.0
21.128	26	48.0	1.64	77.3	25.8	59.0	0.07	0.065	0.0203	1.649	0.515	0.41	0.071	0.0153	1.807	0.389	6.7	175.7
21.197	27	48.5	2.05	77.3	25.8	59.1	0.07	0.054	0.0148	1.359	0.376	0.02	0.057	0.0085	1.445	0.216	3.7	142.8
21.269	28	46.5	1.49	71.5	23.8	59.9	0.06	0.054	0.0126	1.364	0.320	0.00	0.057	0.0058	1.450	0.146	3.7	143.3

MTD (mm) M = 1.437 SD = 0.1309 H = 1.649 L = 1.335
MPD (mm) M = 1.542 SD = 0.1636 H = 1.807 L = 1.414
Left Wheel N = 5 M = 46.1 SD = 2.25 H = 48.5 L = 43.6