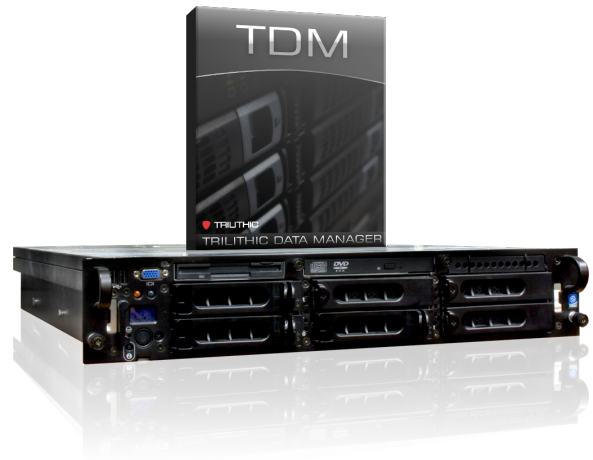


Why TDM?

Improving Operations through Test Data Management

Abstract:

Trilithic has developed a comprehensive productivity increasing, cost reducing system for managing test instruments and the data collected during installations for cable TV systems. The TDM (Test Data Management) system provides valuable information for effective analysis and tracking of performance according to standards that helps to improve reliability of installations and improves customer satisfaction. The following paper explains system benefits for cable systems.



The cable industry is facing strong competition from traditional telephone companies, direct broadcast satellite, and even public utilities in some areas. In order to maintain competitive strength, the industry must find ways to cut operation costs and increase service differentiation. In some instances, cable has a less than perfect quality reputation. Ideally, to improve their competitive position, the cable industry will find ways to increase service quality while decreasing operation cost. One way to do this is with the implementation of a test data management system that provides a means for assuring installation and service quality, and monitoring and improving installation technician performance.

The importance and benefit of quality assurance at the installation may be better understood by looking at the costs associated with poor installation quality. First, the customer is unhappy, having already set aside a significant portion of their day for the “installation window,” they now must set aside additional time to meet the “service window.” In a highly competitive market, it is especially important to make sure customers don’t find a reason to go elsewhere with their money. In addition, the cable company must roll a truck to service the customer, the cost

of which is increasing severely with fuel prices. The gravity of the situation increases dramatically if the first service call is ineffective.

Cost-reducing quality assurance processes can be efficiently and effectively implemented with systems and tools that are now available. Traditionally, technicians are equipped with meters/analyzers for verifying installations and for troubleshooting. One of the keys to quality assurance is to make sure technicians are using their analyzers according to company procedures. There are a few ways to do this. The most primitive is to have the tech make measurements and write down the results on a form. There may be a temptation to save time on this by filling in the form with “imaginary” numbers after leaving the customer premises. This temptation can be removed with the use of analyzers that perform automated tests, or macros. The technician simply runs a macro at the STB (set top box) and saves the results, which can be printed and saved as a record of the installation quality. The macro saves the technician time because he doesn’t have to tune the meter to each signal and record a measurement. In cases where the installation technician discovers a problem that is present at the tap, running a simple macro and saving that data for the service/maintenance technician can save precious time in getting to the root cause of the problem.

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Tests that can be included in a macro include the following:

- Tilt
- Hum
- C/N
- Percent modulation
- QAM (with or without constellation)
- Scan
- Spectrum
- Ping
- Throughput
- VoIP RTP
- CMSTAT (cable modem statistics)

The next consideration is the method for collecting the data for analysis from installers in the field. Traditionally, the technician would connect the analyzer to a PC at the end of each day and upload the data. Currently, in many cases installation technicians have been issued analyzers with embedded cable modems that enable them to test and troubleshoot high speed data and telephony services. These modems can also be used to transmit the test data to a central server for inclusion in a comprehensive database. Having the measurement information in a database opens new windows of information for control and management. Reports can be run on a schedule to help managers identify installations with bad or incomplete measurement data, with the potential to proactively catch customer problems before they call for service. The reports help to identify technicians that are missing steps in procedure or are turning in bad measurement results and need coaching or training (more on reports later).

A high percentage of installation services are performed by contracted technicians. The test data management system can be used as a quality assurance tool for contractors, and the measurement data for each install kept in

records, or even sent to the cable company along with the invoice for services rendered. This helps the contractor ensure that the job is done right, and eliminate “bill-backs” that occur when a service call is generated after an install. The control ensures that technicians are performing optimally, results in a higher quality service to cable companies, and improves the contractor’s competitive position.

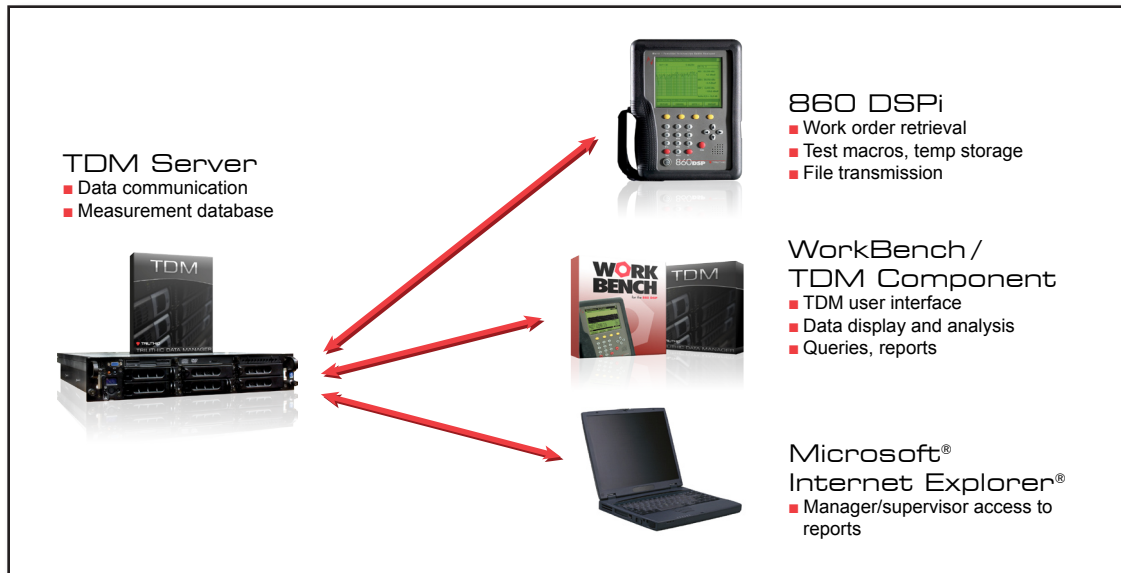
- To summarize, the test data management system provides the following benefits:
- Improves installation service quality – ***retaining satisfied customers***
- Controls installation technician performance – ***eliminating costly rework***
- Saves troubleshooting time for maintenance technicians – ***cutting operation expense***
- Decreases the number of service calls – ***cutting operation expense***
- Speeds installation technician measurement and data collection time – ***improving productivity***

The major components of the Trilithic TDM system are shown in the above diagram. The 860 DSPi is the installation technician’s analyzer which is used to perform tests to verify service installation quality. The WorkBench/TDM Component is the user interface client for TDM, and is an access point for data display and analysis as well as report creation and query generation. Managers and/or Supervisors can also access reports (depending on system integration) using an IE browser. The TDM server handles communication of information and is the keeper of the database.

In addition to the features and benefits summarized above, TDM provides a means for a supervisor to send configuration or firmware changes to individuals or groups of technicians, and to track the implementation of

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these changes. The system provides an easily accessible database of 860 DSPi analyzer inventory, including the last calibration date and what optional features are installed on the meter. One of the TDM system reports provides a means for tracking whether technicians are performing periodic analyzer calibration verifications.

For a better understanding of the TDM system, a review of the process, including the people involved, the actions they perform, and the flow of information is in order. The TDM Integrated Server Package consists of a powerful preconfigured server, including Microsoft Windows Server 2003, SQL, TDM server application, and WorkBench. WorkBench with TDM Component is a powerful client that is used to control the TDM system, configure 860 DSPi's, store measurement data, generate reports, and create custom database queries. The 860 DSPi is the analyzer used by installation technicians to make verification measurements and troubleshoot. Let's take a look at the people who benefit from using the TDM system.

Managers

Managers need a way to track technician performance and control quality of installations.

A number of variables can affect technician performance and installation quality, and for test equipment it includes having the right test configuration, and running the right tests for the type(s) of service(s) being installed. The TDM system enables managers to track progress on technician goals for productivity and compliance with standard procedure. A variety of reports are accessible using WorkBench with TDM Component, or via Internet Explorer browser (depending on system integration) with summaries that expand to show as much detail as needed, up to showing actual measurement results.

- The reports help the manager to easily identify individuals or groups that would benefit from procedural and technical training
- Possible distribution system problems are revealed through detection of "hot spot" patterns
- Customers with repetitive quality problems can be identified and given special attention
- The cable company benefits from lower operating expenses due to dramatic decreases in call back truck rolls

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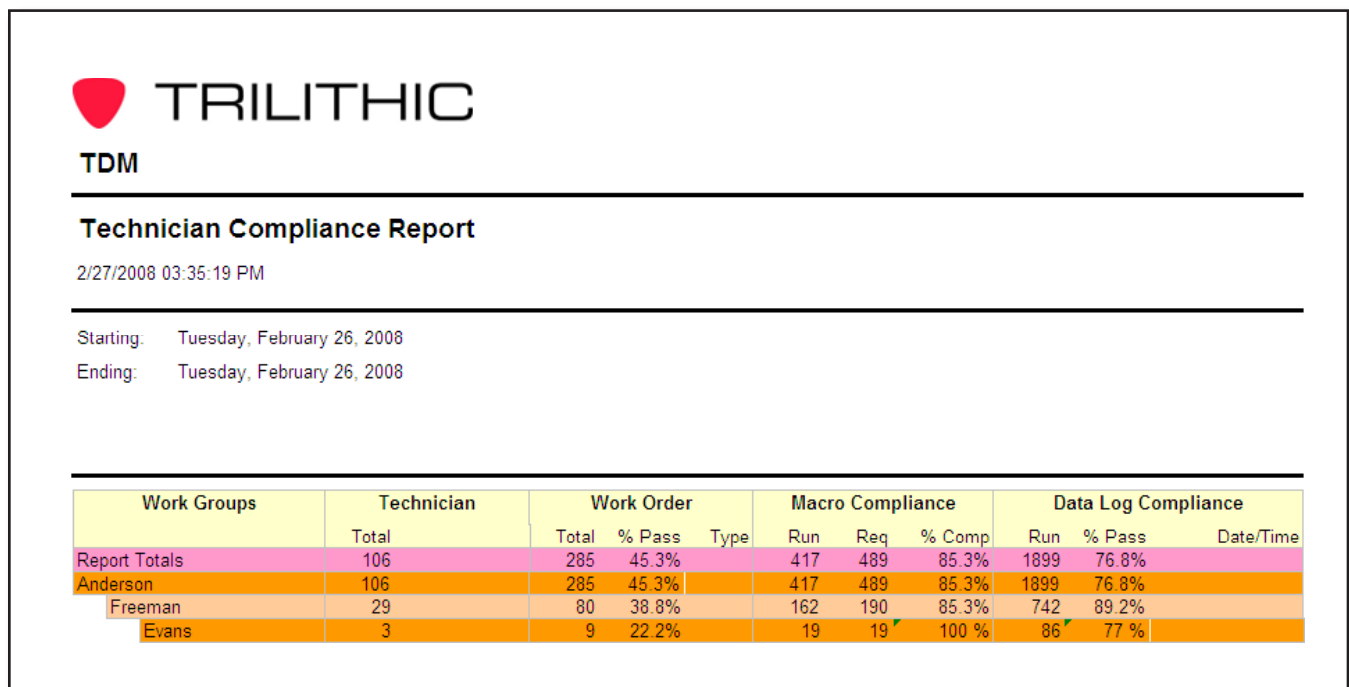
Reports are a very important TDM feature for managers. The vast amount of data collected by installers throughout the day would be overwhelming to analyze without simple, well-designed reports. All TDM reports have certain characteristics, including a summary and expandable/contractible depth of data detail (some reports are only obtainable with data from the billing system, which currently works best using the “flat file” or CSV file from that system that includes information related to work orders).

Note that this summary level of the Technician Compliance Report indicates the number of work orders that have been processed, the percentage that passed, the percentage of macros (auto tests) that have been run, and the percentage of data logs that have passing results. The lower levels indicate these results for specific work groups, and the report viewer has the ability to expand the data for any one of those work groups.

Looking at the report data we see that “Evans” has 3 technicians reporting, they’ve processed a

total of 9 work orders in the time covered by the report, and only 22.2% of those work orders have passing results. The technicians ran 100% of the macros that they were supposed to run for the services they were installing, but only 77% of the associated tests had passing results.

Let’s drill down for some more information...



TRILITHIC
TDM

Technician Compliance Report

2/27/2008 03:35:19 PM

Starting: Tuesday, February 26, 2008
Ending: Tuesday, February 26, 2008

Work Groups	Technician	Work Order			Macro Compliance			Data Log Compliance		
		Total	% Pass	Type	Run	Req	% Comp	Run	% Pass	Date/Time
Report Totals	106	285	45.3%		417	489	85.3%	1899	76.8%	
Anderson	106	285	45.3%		417	489	85.3%	1899	76.8%	
Freeman	29	80	38.8%		162	190	85.3%	742	89.2%	
Evans	3	9	22.2%		19	19	100%	86	77%	

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Work Groups	Technician	Work Order			Macro Compliance			Data Log Compliance		
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Freeman	29	80	38.8%		162	190	85.3%	742	89.2%	
Evans	3	9	22.2%		19	19	100%	86	77%	
	1504	1	0.0%		3	3	100%	14	86%	
		x 446805		G4	3	3	100%	14	86%	6/5/2007
					✓ at tap			6	100%	6/5/2007
								✓ Scan		10:37:19 AM
								✓ HUM		10:37:25 AM
								✓ QAM		10:37:43 AM
								✓ QAM		10:37:49 AM
								✓ QAM		10:38:06 AM
								✓ CM Stat		10:38:49 AM
		x drop cert						2	50.0%	6/5/2007
								x Spectrum		10:39:47 AM
								✓ Scan		10:39:52 AM
		x set top						6	83.3%	6/5/2007
								x Scan		11:41:06 AM
								✓ QAM		11:41:11 AM
								✓ QAM		11:41:18 AM
								✓ QAM		11:41:22 AM
								✓ HUM		11:41:29 AM
								✓ CM Stat		11:42:11 AM

The report viewer can adjust the amount of detail by expanding or contracting at different levels. For example, it can show the detail for a supervisor, with the summary data on that line, and then a summary of the results for each technician. A particular technician's data can be expanded – as shown in this example – to show which work order didn't pass (note the red "x"), which macros didn't pass, and which data logs (tests) from the macro had failing results. On a live connection, the data logs in the report are links to the actual data log information. In this case, the drop certification test of the spectrum failed, and the scan of system signals at the set top box failed.

In some cases, an installer will uncover a problem that is caused in the distribution portion of the HFC plant, and not in the drop. In these cases, the installer may be asked to make a set of measurements using a "tap macro" that provides information that will help the service or maintenance technician find the source of the problem more quickly.

On the following page is an example of the first part of a "tap macro summary."


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The macro summary is kind of a misnomer, because it not only summarizes the data taken, but also provides a fairly comprehensive listing of the test data. In the example above, just the top part of a report is shown, which really is a summary. For this particular report, one can quickly see that it failed the "Scan" and

"Spectrum" tests. Next, channel detail is provided showing exactly which channels were out of limit in red, as well as providing a down arrow indicating that the level was too low.

Excerpts from the bottom part of the report are shown on the following page.









860 DSP Macro Summary

<table style="width: 100%; border-collapse: collapse;"> <tr><td>Macro:</td><td>at tap</td></tr> <tr><td>Result:</td><td>Failed</td></tr> <tr><td>Test Date/Time:</td><td>2/26/2008 09:38:12 AM</td></tr> <tr><td>Channel Plan:</td><td>ltb1.plan</td></tr> <tr><td>Meter Operator:</td><td>5008</td></tr> <tr><td>Meter Cal Date/Time:</td><td>1/20/2007 12:04:31 PM</td></tr> </table>	Macro:	at tap	Result:	Failed	Test Date/Time:	2/26/2008 09:38:12 AM	Channel Plan:	ltb1.plan	Meter Operator:	5008	Meter Cal Date/Time:	1/20/2007 12:04:31 PM	<table style="width: 100%; border-collapse: collapse;"> <tr><td>Sys Prin:</td><td>8798 1000</td></tr> <tr><td>SchedDate:</td><td>2/13/2008</td></tr> <tr><td>Tech:</td><td>5008</td></tr> <tr><td>Task Id:</td><td>214830</td></tr> <tr><td>CUST_ACCT_NO_SBB:</td><td>1205000000000</td></tr> <tr><td>Address:</td><td>791 SUMMIT AVE</td></tr> <tr><td>City:</td><td>Indianapolis</td></tr> <tr><td>STATE:</td><td>IN</td></tr> <tr><td>Node:</td><td>LF14D</td></tr> <tr><td>Resolutions:</td><td>443</td></tr> <tr><td>Type:</td><td>AS</td></tr> <tr><td>CompDate:</td><td>2/26/2008</td></tr> <tr><td>HSE_KEY_HSE:</td><td>60045600000000</td></tr> <tr><td>Zip:</td><td>46235</td></tr> <tr><td>FRAN_TAX_AREA:</td><td>F8633</td></tr> </table>	Sys Prin:	8798 1000	SchedDate:	2/13/2008	Tech:	5008	Task Id:	214830	CUST_ACCT_NO_SBB:	1205000000000	Address:	791 SUMMIT AVE	City:	Indianapolis	STATE:	IN	Node:	LF14D	Resolutions:	443	Type:	AS	CompDate:	2/26/2008	HSE_KEY_HSE:	60045600000000	Zip:	46235	FRAN_TAX_AREA:	F8633
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STATE:	IN																																										
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Resolutions:	443																																										
Type:	AS																																										
CompDate:	2/26/2008																																										
HSE_KEY_HSE:	60045600000000																																										
Zip:	46235																																										
FRAN_TAX_AREA:	F8633																																										

Macro Summary

Scan:	Failed
Spectrum:	Failed
Throughput Upstream:	Passed
Ping:	Passed
Throughput Downstream:	Passed
VoIP:	Passed

Channel Detail

Channel	Frequency	Level	V/A Delta	C/N	Hum	MER	PreFEC BER
3	 61.2500	LV ▼ 1.809	VA 14.910				
4	 67.2500	LV ▼ 2.449	VA 14.203				
5	 77.2500	LV ▼ 2.109	VA 13.875				
6	 83.2500	LV ▼ 2.965	VA 14.801				
98	 109.2500	LV 3.945	VA 14.504				
99	 115.2500	LV 3.859	VA 14.625				
14	 121.2500	LV 4.043	VA 14.133				

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Channel Summary: Failed			View data log		
Test	Value	Limit	Test	Value	Limit
Min Video Level: Failed	-1.660	3.000	Min Digital Level	-4.90	-7.00
Max Video Level	6.813	20.000	Max Digital Level	6.56	10.00
Min V/A Delta	12.762	10.000	Min MER: Failed	33.62	34.00
Max V/A Delta	15.988	17.000	Max BER: Failed	1E-5	1E-7
Max Video Delta	8.473	17.000	Max Corrected BER: Failed	1E-5	< 1E-9
Max Adjacent Video Delta	1.914	3.000			

Spectrum: Failed			View data log	
Test	Value	Limit	Parameter	Value
Max Level: Failed	-14.305	-30.000	Start Frequency	4 MHz
Max Level Frequency	10.080		Stop Frequency	42 MHz
Min Level	-49.520	-70.000	Resolution Bandwidth	300 KHz
Min Level Frequency	4.127		Detector Mode	DwellWide (128)
			Reference Level	0 dBmV
			Hold	Max

These are just two of the test summaries provided, chosen because they provide an example of failed test results. One can quickly see the channel characteristics that failed the test in red. There was at least one channel with minimum video level too low, at least one with MER too low, and at least one with BER problems. The spectrum summary shows in red that something at 10.08 MHz exceeded the maximum level setting. This is probably an ingress signal.

Supervisors

The TDM system enables supervisors to make sure every tech's meter has the proper configuration to ensure that the right tests are done on the right channels. Firmware upgrades can be forwarded to technicians' inboxes and Supervisors can track which meters have been updated. Complete meter inventory reports provide a quick reference indicating which meters have specific measurement capabilities, and when the last calibration was performed. A calibration check report provides a quick method

for ensuring that technicians are checking meter calibration on schedule, and that all meters are making accurate measurements. The supervisor can access specific uploaded data logs for detailed analysis using WorkBench.

The excerpt on the following page from a meter inventory report shows the detailed information provided.

Why TDM?

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860 DSP Meter Inventory

Friday, August 08, 2008

Ordered By: Operator

Operator	Model	Firmware	Connected	Calibrated	Analog Options	Digital Options	Return Options	DOCSIS Options	Other Options
1048	860 Power Pack	6.12.7.2	286	10/18/2004		2 Digital QAM (4..256) QAM Lite	1 Return Return Install (RSVP)	2 DOCSIS	Ethernet Web Browser
1049	860 Power Pack	7.2.26.2	285	3/16/2007	1 Analog Frequency Range 1000	3 Digital QAM (4..256) QAM Lite Enhanced Digital	1 Return QAM Source	5 DOCSIS	Ethernet Web Browser CM to RJ-45 Dual CM MAC High Speed Throughput
1050	860 Power Pack	7.2.26.2	296	3/15/2007	1 Analog Frequency Range 1000	3 Digital QAM (4..256) QAM Lite Enhanced Digital	1 Return QAM Source	5 DOCSIS	Ethernet Web Browser CM to RJ-45 Dual CM MAC High Speed Throughput
1051	860 Power Pack	7.2.26.2	296	3/15/2007	1 Analog Frequency Range 1000	3 Digital QAM (4..256) QAM Lite Enhanced Digital	1 Return QAM Source	5 DOCSIS	Ethernet Web Browser CM to RJ-45 Dual CM MAC High Speed Throughput

Some systems have technicians do a quick accuracy check of analyzer calibration on a scheduled basis. This can be done with a macro, and the saved results can be accessed with a report that shows which technicians have checked calibration, and which meters are out of calibration.

Installation Technicians

The TDM system helps installation technicians become more professional, thorough and efficient. They quickly check and certify the installations with simple macros, verifying the quality of services delivered to customers. The tests are done quickly with one of the fastest installation analyzers on the market, so the installer can get more done in less time.

To further simplify the process for the technician, the 860 DSPi can be set up with a very friendly user-customized interface to enable quick access to specific macros that comprehensively evaluate the services in one combination of

measurements. In a common application scenario, the test data is stored in a task (work order) folder, and all of the data from the day's work is uploaded to TDM at the end of the day. Alternatively, the data can be uploaded at any management designated time, for example, at the completion of each work order, or when it is convenient, or when their supervisor requests it.

TDM with Billing System Connection

An interesting dynamic is added to the TDM system when it has the capability to receive a CSV "flat file" from the cable company billing system enabling the inclusion of information about work orders. This enables the download of information for assigned work order to individual technicians' 860 DSPi's, and the creation of a task (work order) folder for each assigned work order. The technician saves the macro data log in the task folder corresponding to the work order for each job. When the data logs are uploaded, they are matched with information in the flat file, and attributes related to the work order that

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weren't part of the measurement process are added to the database in TDM.

This provides an added dimension to management reports. Based on the information fed from the billing system, reports can be generated that include work order information not specifically related to the measurements but correlating the measurements to specific work orders. Here's how it impacts a macro summary that is used as a "home health check."

Note the relevant information in the report header that came from the work order attributes in the CSV "flat file." A house history report can be

generated that shows a chronologically sorted list of all work orders related to that address.

Implementation of the TDM system leads to satisfied customers with service that meets expectations and improved reliability. The system improves productivity by eliminating rework, and provides management with control and productivity improvement metrics. The ability to collect, sort and analyze data gives new productivity enhancing insight to users and the integration provides a cost cutting quality improvement which by increasing subscriber satisfaction mitigates churn and improves potential for new customer business.

Trilithic TDM Reports - [Macro Summary]

File Tools Window Help

1 of 1 100% Find | Next

TRILITHIC 860 DSP Macro Summary

Macro: **set top** Job ID: 747903
Result: **Failed** Tech: 1235
Test Date/Time: 6/29/2007 12:21:13 PM Schd: 06/29/2007
Channel Plan DS: COMPLETE
Meter Operator: 1235 TS: 1-5P
Meter Cal Date/Time: 10/12/2006 10:41:48 AM Type: G4
Reasons: SC:CSSR SALE
Resolutions: RTC:
Address: 159 PACCHETTI WAY
City: MOUNTAIN VIEW
MapCd: GHCKB
Drop Tag #1: NOTAG

Macro Summary

Scan: **Failed**
QAM Ch 98: **Failed**
QAM Ch 94: **Passed**
QAM Ch 101: **Passed**
Hum Ch 2: **Passed**
Modem Stats: **Failed**

Channel Detail

Channel	Frequency	Level	V/A Delta	C/N	Hum	MER	PreFEC BER
2 KTVU-2	55.250	LV 5.70	VA 14.27		HM 0.3 %		
3 KNTV-11	61.250	LV 5.47	VA 14.54				
4 KRON-4	67.250	LV 5.34	VA 14.59				
5 KPIX-5	77.250	LV 5.04	VA 13.18				
6 KICU-36	83.250	LV 5.75	VA 15.30				
98 BAM 5	111.000	LV -1.35				ME 32.99	BE 5E-7